SECRET

25X1

25X1

25X1

AIRCRAFT T-16
Technical Description

BOOK FOUR

Part 1

Electrical, Radio and
Camera Equipment

SECRET

25X1

[redacted] 25X1

25X1

SECRET
Copy No. 163

AIRCRAFT Ty-16
Technical Description
BOOK FOUR
Part 1
Electrical, Radio and Camera Equipment

25X1 [redacted]

25X1

C O N T E N T S

The Book contains 338 pages and 13 Inserts;
111 drawings are given in the end of the Book.

Chapter I

ELECTRICAL EQUIPMENT

GENERAL

The aircraft D.C. mains is powered by four generators, type ГСР-18000, rated for 18 kW each. The generators are connected in parallel to the mains and produce a power total of 72 kW at 28 to 28.5 V. The generators are driven by the aircraft engines, type РД-3М.

In addition to the generators the aircraft is provided with a starter-type battery 12САМ-55, 55 ampere-hours capacity (at a discharge current of 11 A).

The storage battery operates in parallel with the generators, and also serves as a standby power source.

For current alternation the aircraft is provided with two inverters, type ПО-4500, which produce an alternating current of 400 c.p.s., 115 V. One of the inverters is operating, the other is standby.

The aircraft mains can be connected to ground power sources by means of two ground power supply plug connectors mounted on the aircraft fuselage. One of the plug connectors is used to connect a D.C. power source, while the other connects A.C. power sources.

The aircraft electrical circuit is a single-wire network; the wiring is done with non-shielded and shielded wire, type БПВЛ, the aircraft structure being utilized as the minus conductor. For the purpose of decreasing the weight of the electrical equipment the D.C. supply line is wired with aluminium wire, type БПВЛА.

The main electric power consumers on the aircraft are:

1. Engine starting system consisting of electric starting units and engine instrumentation.
2. Engine fuel supply electric units (fuel pumps, pump control electrical equipment, fire-fighting equipment, fuel gauge, etc.).
3. Aircraft control electric units (autopilot, actuators of flaps, trim tabs and tail skid, wheel automatic braking system, hydraulic pump, explosive charge mechanisms for releasing and dropping of the drag chute).
4. Flight control and navigating electric units (gyro horizons, directional gyros, remote-indicating induction compass, dead reckoning (aircraft position) instrument system and remote-indicating astrocompass).
5. Electric heating and de-icing arrangements (thermal de-icers of tail unit, pilots' and navigator's cabin glass enclosure, electric heaters of the front and rear pressurized cabins, electric heaters of battery containers, autopilot servo units and other instruments).
6. Aircraft internal illumination system (cabin dome lights, directed light fixtures and ultra-violet illumination arrangements).
7. Aircraft external light system (landing lamps, taxiing lamps, leader-initiated bombing lamps, as well as formation and navigating lights).
8. Aircraft system of light and sound signalization.
9. Bombing and cannon systems.
10. Radio and radar systems.

The total current consumed by the maximum number of simultaneously energized power consumers amounts to approximately 1700 A (the cabin heaters consume 340 A, the glass enclosure de-icers require 190 A, the tail unit de-icers take 470 A, the cannon system - 250 A, and the permanently engaged consumers require approximately 450 A).

Thus, the power which can be continuously picked up from the generators, is utilized by the aircraft power consumers

under adverse weather and combat conditions not more than by 70 per cent. This means that the aircraft has an excess electric power which adds to the reliability of the electric system operation in case of failure of one of the power supply sources available; this also ensures voltage stability in the aircraft mains when powerful consumers are supplied.

Section 1

C I R C U I T R Y

The aircraft electric circuit consists of electric wires, switching equipment, as well as of control and protection arrangements. The circuit employs a single-wire diagram, with the aircraft structure utilized in the function of the minus wire.

Minus wires of power consumers are connected to the aircraft structure in six points: in four points from the generators (on the fuselage port and starboard sides, at frame No.44), from the storage battery on frame No.17, port side, and from the ground supply plug connector in the nose wheel well, port side, at frame No.15.

Minus wires of separate power consumers are connected to the airframe in the installation area of each particular unit. The minus wire connection points are marked with red paint.

For better dependability of power consumer operation and as a measure against possible spot overheating and electrical corrosion of some units and joints, all the aircraft units and equipment items are reliably bonded.

The aircraft electrical circuit consists of separate feeders.

For the list of feeders and their protecting arrangements see Table 1.

The entire electrical circuit of the aircraft is divided into the following:

1. The direct current circuit, with voltage within 28 to 28.5 V, supplied from the generators, type ГСР-18000, and storage battery, type 12САМ-55.

2. The single-phase A.C. circuit, 115 V, at a frequency of 400 c.p.s., supplied from the two ПО-4500 inverters (operating and standby).

In its turn, the D.C. circuit consists of:

(a) normal supply circuit;

(b) emergency supply circuit;

(c) dual supply circuit.

Due to the fact that all these circuits are directly connected with the supply sources and with the power distribution system, the circuits are discussed in detail in Section 2 of the present Chapter.

The electrical wiring is done with copper wire, type БПВЛ, with colour insulation, and with aluminium wire, type БПВЛА, with white insulation.

The radio equipment wires are light blue, the armament system wires are red, the wires of the aircraft A.C. mains are yellow, and all other wires are white.

To reduce radio interference and interference to the radar equipment, part of the copper wires in the interphone system is shielded, and wire, type БПВЛЭ, is used. For the same purpose part of copper wires is encased in common shielding braidings.

For the types of wires and their total lengths see Table 2.

Feeders and Circuit-Protecting Arrangements

Nos	Group	Feeder group	Feeder	Feeder supply bus bar	Power consumer	Protecting arrangement: type	Protecting arrangement: current, A	Protecting arrangement: location
1	2	3	4	5	6	7	8	9
1	A	Automatic equipment	АБ	115 V, A.C.	Fuel flow controller, left	СП	1	Navigator's fuse panel, 115 V, A.C.
2			АВ	115 V, A.C.	Fuel flow controller, right	СП	1	
3			АГ	Д	Fuel flow controller, left	АЗС	5	Co-pilot's circuit breaker panel
4			АД	Д	Fuel flow controller, right	АЗС	5	
5			АЖ	Н	ТРТВК thermostat of front pressurized cabin	АЗС	2	
6			АИ	Н	ТРТВК thermostat of rear pressurized cabin	АЗС	2	Second cabin circuit breaker panel

25X1

25X1

1	2	3	4	5	6	7	8	9
7			АК	Д	Dead reckoning instrument system, type НИ-50Б	А3С	5	Navigator's circuit breaker panel, left
8			АП	Н	Autopilot, type АП-5-2М	А3С	15	Pilot's circuit breaker panel
9			АР	Н	Co-pilot's glass panel heater control	А3С	2	Co-pilot's circuit breaker panel
10			АС	Н	Pilot's glass panel heater control	А3С	2	Pilot's circuit breaker panel
11			АТ	Н	Navigator's glass panel heater control	А3С	2 }	Navigator's circuit breaker panel, left
12			АП16 АП116	-	Autopilot vertical flight gyro motor	А3С	5 }	
13			АП17 АП117	-	Torque motor of autopilot	А3С	2 }	
14			АУ	Т	Automatic wheel brake control	А3С	10	Pilot's circuit breaker panel
15	В	Armament systems	ВА	Д	Emergency bomb release control	А3С	5	Navigator's circuit breaker panel, right

1	2	3	4	5	6	7	8	9
16			ВБ	Д	Combat bomb release power supply	А3С	15 }	Navigator's circuit breaker panel, left
17			ВБ1	Д	ARMED-SAFE control system	А3С	10 }	
18			ВБ2	Д	ARMED at emergency bomb release	А3С	10	Navigator's circuit breaker panel, right
19			ВБа	Д	Fuze circuits (left forward)	СП	5 }	Combat bomb release junction box
20			ВБ6	Д	Fuze circuits (right forward)	СП	5 }	
21			ВБв	Д	Fuze circuits (left aft)	СП	5 }	
22			ВБг	Д	Fuze circuits (right aft)	СП	5 }	
23			ВД	Д	Emergency bomb release control relay	А3С	2	Navigator's circuit breaker panel, right
24			ВЕ	Д	Emergency bomb release control relay	А3С	2	Navigator's circuit breaker panel, right

25X1

1	2	3	4	5	6	7	8	9
25			BI	Д	Normal bomb release blocking relay	A3C	2	Navigator's circuit breaker panel, left
26			BM	Д	Combat bomb release blocking relay	A3C	2	
27			BH	Д	Emergency bomb release power supply system	ИП	50	Dual supply junction box, right
28			BП	Д	Bombsight power supply system	A3C	15	Navigator's circuit breaker panel, left
29			BP	Д	Bomb release variant selector box (КВСБ) power supply system	A3C	5	
30			BC	H	Forward cannon mount power supply system	A3C	10	Pilot's circuit breaker panel
31			BЛ	Д	Rear bomb rack disconnecting relay	A3C	2	Navigator's circuit breaker panel, left
32	3	Starting	+3	Д	Starting power supply system	A3C	25	Pilot's circuit breaker panel
33			1_3A	Д	Left engine air valvo	A3C	5	

1	2	3	4	5	6	7	8	9
34			1_3B	Д	Left engine starting system	A3C	15	Pilot's circuit breaker panel
35			1_3H	Д	Left engine starting control system	A3C	5	
36			1_3П	T	Left engine in-flight starting	A3C	20	
37			2_3A	Д	Right engine air valve	A3C	5	
38			2_3B	Д	Right engine starting system	A3C	15	
39			2_3H	Д	Right engine starting control system	A3C	5	
40			2_3П	T	Right engine in-flight starting	A3C	20	
41			3Ф	H	Tachometers of turbo-driven starters	–	–	
42	И	Inverters	ИЛ	Д	Inverter, ПО-4500 type (standby)	ТП	400	Dual supply distribution box at frame No.17
43			ИП	H	Inverter, ПС-4500 type (operating)	ТП	400	Storage battery distribution box

1	2	3	4	5	6	7	8	9
44	Л		ЛБ	Н	Extension system of dipole reflectors No.1	АЗС	10	Radio operator's circuit breaker panel
45			ЛВ	Н	Extension system of dipole reflectors No.2	АЗС	10	
46			ЛГ	Н	Extension system of dipole reflectors No.3	АЗС	10	
47			ЛД	Н	Extension system of dipole reflectors No.4	АЗС	10	
48	М		МБа	Д	Fuel pump of tank No.19 (left)	ИП	15	Distribution panel of left engine nacelle
49			МБб	Д	Fuel pump of tank No.16 (left)	ИП	50	
50			МБв	Д	Fuel pump of tank No.10 (left)	ИП	50	
51			МБг	Д	Fuel pump of tank No.2	ИП	50	Fuel pump junction box, left
52			МБд	Д	Fuel pump of tank No.3	ИП	75	Fuel pump junction box, right
53			МБе	Д	Fuel pump of tank No.4	ИП	75	Fuel pump junction boxes on frame No.49
54			МБж	Д	Fuel pump of tank No.5	ИП	50	
55			МБз	Д	Fuel pump of tank No.6 (left)	ИП	50	Fuel pump junction box, left

1	2	3	4	5	6	7	8	9
56			МБи	Д	Fuel pump of tank No.6 (right)	ИП	50	Fuel pump junction box, right
57			МБк	Д	Fuel pump of tank No.10 (right)	ИП	50	Distribution panel of right engine nacelle
58			МБл	Д	Fuel pump of tank No.16 (right)	ИП	50	
59			МБм	Д	Fuel pump of tank No.19 (right)	ИП	15	
60			МБф	Т	Fuel shut-off valve of left engine	АЗС	5	Co-pilot's circuit breaker panel
61			МБх	Т	Fuel shut-off valve of right engine	АЗС	5	
62			МБэ	Т	Fuel stop valve	АЗС	5	
63			МВб	Н	Fans of pilot, co-pilot and navigator	АЗС	5	Pilot's circuit breaker panel
64			МВм	Н	Front pressurized cabin heater control system	АЗС	30	Co-pilot's circuit breaker panel
65			МВн	Н	Rear pressurized cabin heater control system.	АЗС	30	Rear cabin circuit breaker panel

S-E-C-R-E-T

25X1

1	2	3	4	5	6	7	8	9
66			МВо	Н	Radar operator's fan	АЗС	2	Radar operator's circuit breaker panel
67			МВс	Н	Fans of gunner, radio operator, and ПРС-1 units	АЗС	5	Rear cabin circuit breaker panel
68			МГ	Н	Hydraulic pump power supply	ИП	250	Hydraulic control panel junction box
69			1Мз	Н	Left engine starter actuation system	ИП	200	Distribution panel of left engine nacelle
70			$2М_3$	Н	Right engine starter actuation system	ИП	200	Distribution panel of right engine nacelle
71			МК	Н	Low-altitude ventilation system of front pressurized cabin	АЗС	2	Circuit breaker panel of pilot
72			МХ	Н	Tail skid actuator	ИП	5	Dual supply junction box at frame No.17
73			МБр	Д	Additional fuel pump of tank No.2	ИП	50	Junction box of additional fuel pump of tank No.2

1	2	3	4	5	6	7	8	9
74			МБо	Д	Additional fuel pump of tank No.5	ИП	50	Junction box of additional fuel pump of tank No.49
75			МУ	Д	Flap actuator (electric motor No.2)	ИП	150	Dual supply junction box, right
76			МЩ	Д	Flap actuator (electric motor No.1)	ИП	150	Dual supply junction box, left
77	0	Lighting	ОА	Т	Emergency ultra-violet illumination, extension lamp socket, КИ-12 compass illumination	АЗС	5	Co-pilot's circuit breaker panel
78			ОБ	Н	White light illumination of front pressurized cabin	АЗС	5	
79			ОВ	Н	Extension lamp socket	СП	5	Fuel pump junction box, right
80			ОД	Н	Illumination of fuselage compartment between frames Nos 17 and 22	СП	5	Dual supply junction box

25X1 25X1

25X1

1	2	3	4	5	6	7	8	9
81			ОВ	Н	Ultra-violet illumination of instrument panel, navigator's right-hand console and sight	АЗС	2	Navigator's circuit breaker panel, left
82			ОЖ	Н	Bomb bay lighting	АЗС	5 }	Radar operator's circuit breaker panel
83			ОИ	Н	L.G. well lighting	АЗС	5 }	
84			ОО	Н	White light illumination of radar operator, pilot and navigator's compartment	АЗС	5	Pilot's circuit breaker panel
85			ОР	Н	Lighting of rear pressurized cabin and fuselage tail section	АЗС	5	Rear panel circuit breaker panel
86			ОТ	Н	Co-pilot's ultra-violet illumination	АЗС	2	Co-pilot's circuit breaker panel
87			ОУ	Д	Ultra-violet illumination of pilot's station and upper control board	АЗС	2 }	Pilot's circuit breaker panel
88			ОФ	Н	Left landing lamp power supply	АЗС	30 }	

1	2	3	4	5	6	7	8	9
89			ОХ	Н	Radar operator's ultra-violet illumination	АЗС	2	Radar operator's circuit breaker panel
90			ОЧ	Н	Ultra-violet illumination of rear pressurized cabin	АЗС	2	Rear cabin circuit breaker panel
91			ЗЦ	Н	Taxiing lamps	АЗС	10 }	Pilot's circuit breaker panel
92			ОЯ	Н	Right landing lamp power supply	АЗС	30 }	
93			ОГ	Н	Extension lamp socket	СП	5	Fuel pump junction box at frame No.49
94			ОК	Н	Extension lamp socket of left L.G. well	СП	5	Extension lamp junction box in left L.G. well
95			ОЛ	Н	Extension lamp socket of right L.G. well	СП	5	Extension lamp junction box in right L.G. well
96			10М	Н	Extension lamp socket of left engine	СП	10	Extension lamp junction box in left engine nacelle
97			20М	Н	Extension lamp socket of right engine	СП	10	Extension lamp junction box in right engine nacelle

1	2	3	4	5	6	7	8	9
98	П	Instruments	ПЕ	Д	Artificial horizon (standby)	АЗС	5	
99			ПВ	Т	Artificial (gyro) horizon of pilot	АЗС	5	
100			ПГ	Д	Artificial horizon of co-pilot	АЗС	5	Co-pilot's
101			ПД	Д	ЭМИ-3р indicator of right engine	АЗС	2	circuit
102			ПЕ	Д	Fuel quantity gauge of left engine tanks	АЗС	2	breaker
103			ПЖ	Д	Fuel quantity gauge of right engine tanks	АЗС	2	panel
104			ПЗ	Д	Fuel flowmeter of left engine tanks	АЗС	2	
105			ПИ	Д	Fuel flowmeter of right engine tanks	АЗС	2	
106			ПК	115 V, A.C.	Remote-indicating compass, type ДГМК-7	СП	2	Navigator's fuse panel (115 V, A.C.)
107			ПЛ	Д	Fuel pressure gauges	АЗС	2	Co-pilot's circuit breaker panel
108			ПМ	Д	ЭМИ-3р indicator of left engine	АЗС	2	

1	2	3	4	5	6	7	8	9
109			ПО		Engine tachometers	-	-	
110			ПП	Т	Pilot's bank-and-turn indicator	АЗС	2	Co-pilot's circuit breaker panel
111			ПР	115 V, A.C.	Fuel quantity gauge of left engine tanks	СП	1	Navigator's circuit breaker panel, 115 V, A.C.
112			ПС	115 V, A.C.	Fuel quantity gauge of right engine tanks	СП	1	
113			ПТж		Exhaust gas temperature gauges	-	-	
114			ПТн	Н	Free air temperature gauges of rear pressurized cabin	АЗС	2	Circuit breaker panel of rear pressurized cabin
115			ПУ	Д	Bank-and-turn indicator of co-pilot	АЗС	2	Co-pilot's circuit breaker panel
116			ПЧ1	115 V, A.C.	Oxygen level indicator transformer	СП	2	Navigator's fuse panel, 115 V, A.C.
117			ПЧ11	45 V, A.C.	Oxygen level indicator of vessel 1	СП	1	
118			ПЧ21	45 V, A.C.	Oxygen level indicator of vessel 2	СП	1	

1	2	3	4	5	6	7	8	9
119			ПШ	Д	Airbrake and free air temperature indicator	АЗС	2	Pilot's circuit breaker panel
120			ПЭ	115 V, A.C.	Fuel flowmeter of right engine	СП	2	Radar operator's fuse panel, 115 V, A.C.
121			ПЮ	Т	Remote-indicating astrocompass	АЗС	5	Co-pilot's circuit breaker panel
122	Р	Radio equip-ment	ПЯ	115 V, A.C.	Fuel flowmeter of left engine	СП	2	Radar operator's fuse panel, 115 V, A.C.
123			РА1	Т	Interphone СПУ-10, channel No.1	АЗС	5	Co-pilot's circuit breaker panel
124			РА10	Н	Interphone СПУ-10, channel No.2	АЗС	5	Radar operator's circuit breaker panel
125			РА20	Т	Interphone call boxes СПУ-10	АЗС	2	Co-pilot's circuit breaker panel
126			РБ	115 V, A.C.	Bombsight, type РБП-4	СП	15	Radar operator's fuse panel, 115 V, A.C.
127			РВ	Н	Radio altimeter, type РВ-2	АЗС	5	Pilot's circuit breaker panel

1	2	3	4	5	6	7	8	9
128			РД	Д	Range-finder, type СД-1	АЗС	2	Navigator's left-hand circuit breaker panel
129			РЕ	115 V, A.C.	Altimeter, type РВ-17М	СП	5	Navigator's fuse panel, 115 V, A.C.
130			РКа	Н	Power supply of communications radio set 1-РСБ-70М	АЗС	50	Circuit breaker panel of rear pres-surized cabin
131			РКб	Н	Power supply of communications radio set, type УС-9	-	-	
132			РН	115 V, A.C.	Automatic radio compass АРК-5 No.1	СП	2	Navigator's fuse panel, 115 V, A.C.
133			РК	Д	Automatic radio compass АРК-5 No.1	АЗС	2	Navigator's left-hand circuit breaker panel
134			РЛ	Д	Automatic radio compass АРК-5 No.2	-	-	
135			РМ	Д	ILS instruments	АЗС	10	Pilot's circuit breaker panel
136			РО	Д	Aircraft transponder	АЗС	5	Co-pilot's circuit breaker panel

1	2	3	4	5	6	7	8	9
137			РП	115 V, A.C.	Radar gunsight, type ПРС-1	СП	15	Radar operator's fuse panel, 115 V, A.C.
138			РР	115 V, A.C.	Automatic radio compass АРК-5 No.2	-	-	Navigator's fuse panel, 115 V, A.C.
139			РС	115 V, A.C.	Command radio station РСИУ-3М	СП	2	Radar operator's fuse panel, 115 V, A.C.
140			РТ	Н	Radio receiver УС-9Д of command radio station 1-РСБ-70М	АЗС	5	Radar operator's circuit breaker panel
141			РУ	115 V, A.C.	Radio receiver УС-9Д of command radio station 1-РСБ-70М	СП	2	Radar operator's fuse panel, 115 V, A.C.
142			РХ	115 V, A.C.	Range-finder, type СД-1	СП	5	Navigator's fuse panel, 115 V, A.C.
143			РЦ	Н	Radar gunsight (amplidyne unit)	АЗС	40	Circuit breaker panel of rear pressurized cabin
144			РЧ	Н	Radar gunsight (junction boxes)	АЗС	20	

1	2	3	4	5	6	7	8	9
145			РШ	Д	Bombsight РБП-4 control system	АЗС	20	Radar operator's circuit breaker panel
146			РЩ	Д	Antenna duplexer of radio altimeters РВ-2 and ГБ-17М	АЗС	2	Pilot's circuit breaker panel
147			РЭ	Т	Command radio station РСИУ-3М	АЗС	5	Radar operator's circuit breaker panel
148			РЮа	Н	Power supply of command radio station 1-РСБ-70М	-	-	Power lead-in on frame No.12 (starboard)
149	С	Signalling system	Рю		Control system of 1-РСБ-70М command radio station folded dipole antenna	-	-	
150			СА	Н	Navigation lights	АЗС	5	Pilot's circuit breaker panel
151			СБ	Д	Left tank group fuel pump warning system	АЗС	2	Co-pilot's circuit breaker panel
152			СВ	Д	Bombing equipment warning system	АЗС	5	Navigator's left-hand circuit breaker panel

1	2	3	4	5	6	7	8	9
153			СТ	Д	Hydraulic system warning unit	A3C	2	Pilot's circuit breaker panel
154			СД	Д	Right tank group fuel pump warning system	A3C	2	Co-pilot's circuit breaker panel
155			СВ	Н	Cabin pressure warning unit of rear pressurized cabin	A3C	2	Circuit breaker panel of rear pressurized cabin
156			СЗ	Д	Sound signalling system of front pressurized cabin	A3C	2	Co-pilot's circuit breaker panel
157			СМ	Д	Airspeed limit warning system	A3C	2	Pilot's circuit breaker panel
158			СО	Д	Cabin pressure warning unit of front pressurized cabin	A3C	2 }	Co-pilot's circuit breaker panel
159			СП	Д	Left tank group fire warning system	A3C	15 }	
160			СР	Н	Signal flares	A3C	5 }	
161			СС1	Н	Formation flight lights, top	A3C	2 }	Pilot's circuit breaker panel
162			СС11	П	Formation flight lights, bottom	A3C	2 }	
163			СУ	Д	Right tank group fire warning system	A3C	15	Co-pilot's circuit breaker panel

1	2	3	4	5	6	7	8	9
164			СФ	Д	Pattern bombing signal lamps	A3C	15	Navigator's left-hand circuit breaker panel
165			СХ	Д	Colour flare bomb normal release	A3C	20 }	Navigator's right-hand circuit breaker panel
166			СЦ	Д	Colour flare bomb door warning and control interlock system	A3C	2 }	
167			СЦ31	Д	Colour flare bomb station status indicator	A3C	2	Navigator's right-hand control panel, flare bomb control board
168			СЧ	Д	Colour flare bomb emergency release system	КП	30	Flare bomb junction box
169			СШ	Д	L.G. warning system	A3C	2	Pilot's circuit breaker panel
170			СЩ	Д	Colour flare bomb emergency release control	A3C	2	Navigator's right-hand circuit breaker panel
171	Т	Heaters	СТ		Trim tab warning system	-	-	

1	2	3	4	5	6	7	8	9
172			ТАс	Н	Stabilizer de-icer (external arrangement)	ТП	600	De-icer junction box
173			ТАт	Н	Stabilizer de-icer (internal arrangement)	ТП	600	
174			ТАу	Н	Fin de-icer	ТП	600	
175			ТД	Н	Storage battery heater	СП	10	Battery junction box
176			ТКм	Н	Heater, Index 107, of front pressurized cabin	ИП	150	Glass panel heater junction box
177			ТКн	Н	Heater, Index 107, of rear pressurized cabin	ИП	150	Power distribution box of rear cabin
178			ТМ	Н	Heater of АП-5-2М autopilot elevator and rudder servo units	АЗС	10	Autopilot heater junction box
179			ТП	Д	Heaters of ТП-156 pitot tubes of co-pilot, bombardier, НИ-50Б dead reckoning instrument system,	АЗС	10	Co-pilot's circuit breaker panel

1	2	3	4	5	6	7	8	9
					ОПБ-11Р bombsight and radio-gunner			
180			ТР	Н	Heaters of directional stabilizer, vertical flight gyro and aileron servo unit	АЗС	10	Pilot's circuit breaker panel
181			ТС	Н	Pilot's glass heater (defroster)	ИП	75	Defroster junction box
182			ТТ	Н	Co-pilot's defroster	ИП	75	
183			ТУ	Н	Navigator's defroster	ИП	100	
184	У	Control	ТЯ	Т	Heaters of ТП-156 pitot tube of pilot, navigator, and heater of ССН-3 (velocity head warning unit)	АЗС	5	Co-pilot's circuit breaker panel
185			УБд	Д	Control of standby pumps of tanks No.16	АЗС	2	Co-pilot's circuit breaker panel
186			УБе	Д	Control of standby pumps of tanks No.6	АЗС	2	
187			УВ	Н	Elevator trim tab control	АЗС	5	Pilot's circuit breaker panel
188			УГ	Н	Hydraulic pump control	АЗС	2	

1	2	3	4	5	6	7	8	9
189			УД	Д	Remote-indicating compass, type ДГМК-7	АЗС	2	Navigator's left-hand circuit breaker panel
190			УЕ	Т	CO_2 bottle control	АЗС	10	Co-pilot's circuit breaker panel
191			УЖ	Д	Emergency drainage	АЗС	2	
192			$У_з1$	Д	Control of left engine group fuel pumps	АЗС	5	Overhead electric control panel of pilots
193			$У_з2$	Д	Control of right engine group fuel pumps	АЗС	5	
194			$У_з3$	Д	Control of second group fuel tanks	АЗС	5	
195			$У_з4$	Д	Control of third group fuel pumps	АЗС	5	
196			$У_з5$	Д	Control of fourth group fuel tanks	АЗС	5	
197			УИ11	Н	Control of ПО-4500 inverter (operating)	АЗС	2	Radar operator's circuit breaker panel
198			УИ21	Д	Control of ПО-4500 inverter (standby)	АЗС	2	

1	2	3	4	5	6	7	8	9
199			УЛ	Д	Bomb bay door control (regular)	АЗС	5	Navigator's left-hand circuit breaker panel
200			УП	Д	Bomb bay door control (emergency)	АЗС	5	
201			УР	Н	Rudder trim tab control	АЗС	5	Pilot's circuit breaker panel
202			УС	Т	Drag chute control	АЗС	5	
203			УТ	Н	Left aileron trim tab control	АЗС	5	
204			УУ	Д	Airbrake control (motor No.2)	АЗС	5	
205			УФ	Н	Left landing lamp control	АЗС	5	
206			УХ	Н	Tail unit de-icer control	АЗС	5	Co-pilot's circuit breaker panel
207			УЧ	Д	Fuel flow control	АЗС	2	
208			УШ	Д	Airbrake control (motor No.1)	АЗС	5	Pilot's circuit breaker panel
209			УЭ	Н	Right aileron trim tab control	АЗС	5	

25X1

1	2	3	4	5	6	7	8	9
210			УД	Н	Inert gas connection	АЗС	5	Co-pilot's circuit breaker panel
211		Photographic equipment	УЯ	Н	Right landing lamp control	АЗС	5	Pilot's circuit breaker panel
212			ФА	Н	Camera АФА-33М	АЗС	15 }	Navigator's right-hand circuit breaker panel
213			ФК	Н	Tilting unit control of АФА-33М camera	АЗС	2 }	
214			ФЛ	Н	ФА-ПЛ-1 camera power supply socket	АЗС	15	Radar operator's circuit breaker panel
215			ФМ	Н	Tilting unit actuator	ИП	10 }	Photographic equipment junction box
216			ФН	Н	Camera hatch door actuator	ИП	5 }	
217			4СТ	Н	Horizontal drive	ИП	75 }	Upper mount supply box
218			40Б	Н	Vertical drive	ИП	75 }	
219			42	Н	Converter	ИП	75 }	
220			244А	Н	Amplifiers	ИП	200 }	

1	2	3	4	5	6	7	8	9
221			340Б	Н	Vertical drive	ИП	75 }	Tail mount supply box
222			344А	Н	Amplifiers	ИП	200 }	
223			34СТ	Н	Horizontal drive	ИП	75 }	
224			342	Н	Converter	ИП	75 }	
225			444А	Н	Amplifiers	ИП	200 }	Lower t supply box
226			440Б	Н	Vertical drive	ИП	75 }	
227			442	Н	Converter	ИП	75 }	
228			44СТ	Н	Horizontal drive	ИП	75 }	
229					Winch plug connector	ИП	100	Fuel pump junction box on frame No.49
230					Winch plug connector	ИП	100	Fuel pump junction box, right
231			+	Н	Rounds counter	-	- }	Power distribution box of rear pressurized cabin
232			+	Н	Tail system control station	-	- }	
233			+	Н	Blister system control station	-	-	Right power lead-in on frame No.69
234			+	Н	Upper system control station	-	-	Left power lead-in on frame No.12
235			ЗГ1	Н	Generator ГСР-18000 No.1 (left engine)	ТП	900 }	Left engine distribution board
236			ЗГ11	Н	Generator ГСР-18000 No.2 (left engine)	ТП	900 }	

25X1

25X1

1	2	3	4	5	6	7	8	9
237			ЗГ21	Н	Generator ГСР-18000 No.3 (right engine)	ТП	900	Right engine distribution board
238			ЗГ31	Н	Generator ГСР-18000 No.4 (right engine)	ТП	900	
239			ЗГ	А	Generator No.2 (left engine), emergency	ТП	900	Left engine distribution board
240			ЗГ	А	Generator No.3 (right engine), emergency	ТП	900	Right engine distribution board
241			ЗА1	АК	Power supply of instruments, with mains de-energized	ИП	35	Storage battery junction box
242			ЗА31	АК	Transponder destructor	-	-	
243			ЗП11	-	115 V.A.C. supply from ПО-4500 inverter (operating)	ИП	50	From operating inverter
244			ЗП21	-	115 V A.C. supply from standby ПО-4500 inverter	ИП	50	From standby inverter
245			ЗС	АК	Emergency bomb release, with mains de-energized	-	-	Storage battery junction box

1	2	3	4	5	6	7	8	9
					Group protection fuses:			
246			Д1	Д	For co-pilot's circuit breaker panel	ИП	75	
247			Д2	Д	For navigator's left-hand circuit breaker panel	ИП	75	
248			Д3	Д	For navigator's right-hand circuit breaker panel	ИП	75	
249			Д4	Д	For radar operator's circuit breaker panel	ИП	30	Dual supply junction box
250			Д5	Д	For pilot's circuit breaker panel	ИП	30	
251			Д6	Д	For overhead electric control panel of pilots	ИП	15	
252			Н1	Н	For navigator's left-hand circuit breaker panel	ИП	10	
253			Н2	Н	For pilot's circuit breaker panel	ИП	100	
254			Н3	Н	For co-pilot's circuit breaker panel	ИП	50	Defroster junction box

1	2	3	4	5	6	7	8	9
255			H4	H	For navigator's right-hand circuit breaker panel	ИП	50	Defroster junction box
256			H5	H	For fuelling control board	ИП	10	
257			Д7	Д	For left junction box of fuel pumps	ИП	150	Dual supply junction box, left
258			Д8	Д	For right junction box of fuel tanks	ИП	150	Dual supply junction box, right
259			+ЭГ3 +ЭГ4 ЭГ3 ЭГ4	-	Ammeter of generator No.1	СП	2	Distribution board of left engine nacelle
260			+ЭГ13 +ЭГ14 ЭГ13 ЭГ14	-	Ammeter of generator No.2	СП	2	
261			+ЭГ23 +ЭГ24 ЭГ23 ЭГ24	-	Ammeter of generator No. 3	СП	2	Distribution board of right engine nacelle
262			+ЭГ33 +ЭГ34 ЭГ33 ЭГ34	-	Ammeter of generator No.4	СП	2	

1	2	3	4	5	6	7	8	9
263			ЭГ2 +ЭГ2	H	Relay ДМР-600 (normal) of generator No.1	ИП	5	Distribution board of left engine nacelle
264			ЭГ12 +ЭГ12	H	Relay ДМР-600 (normal) of generator No.2	ИП	5	
265			ЭА17 +ЭА17	A	Relay ДМР-600 (emergency) of generator No.2	ИП	5	
266			ЭГ22 +ЭГ22	H	Relay ДМР-600 (normal) of generator No.3	ИП	5	Distribution board of right engine nacelle
267			ЭА20 +ЭА20	A	Relay ДМР-600 (emergency) of generator No.3	ИП	5	
268			ЭГ32 +ЭГ32	H	Relay ДМР-600 (normal) of generator No.4	ИП	5	

1	2	3	4	5	6	7	8	9
269			ВАЗ ВА4	-	Ammeter of storage battery	СП	2	Battery junction box

Key to Table 1

The designations in the columns of Table 1 stand for:

Д - dual supply bus bar;
Н - regular supply bus bar;
АЗС - circuit breaker;
СП - fuse link, glass;
МП - fuse link, delayed-action;
ТП - high-temperature fuse;
Т - triple supply bus bar;
А - emergency supply bus bar;
АК - battery supply bus bar.

Table 2

Nos	Type and cross-section (in sq.mm) of wire	Total length of wire per one aircraft, m.			
		white	1/blue	red	yellow
1	2	3	4	5	6
1	БПВЛ0.35	3592	1235	1031	238
2	БПВЛ30.35	875	596	-	116
3	БПВЛ32х0.35	17	447	10	-
4	БПВЛ0.5	3970	1101	807	24
5	БПВЛ30.5	143	244	19	-
6	БПВЛ1.0	1512	473	1040	-
7	БПВЛЭ 1.0	29	25	7	-
8	БПВЛ 1.25	928	60	1277	-
9	БПВЛЭ 1.25	-	6	-	-
10	БПВЛ 1.5	429	47	312	-
11	БПВЛЭ 1.5	2	-	28	-
12	БПВЛ 1.93	218	27	218	12
13	БПВЛЭ 1.93	9	-	-	-
14	БПВЛ 3.0	155	47	1544	13
15	БПВЛЭ 3.0	106	-	-	-
16	БПВЛ 4.0	25	-	-	-
17	БПВЛ 5.15	168	10	25	33
18	БПВЛ 6.0	-	9	7	-
19	БПВЛ 8.8	34	-	10	-
20	БПВЛ 10.0	3	-	-	-
21	БПВЛ 13.0	33	-	11	-
22	БПВЛ 16.0	21	-	-	-
23	БПВЛ 21.0	10	-	-	-
24	БПВЛ 35.0	31	-	11	-
25	БПВЛ 41.0	-	-	18	-
26	БПВЛ 50.0	13	-	-	-
27	БПВЛ 70.0	59	-	-	-
28	БПВЛ 95.0	35	-	13	-

1	2	3	4	5	6
29	БПВЛА 35.0	19	-	-	-
30	БПВЛА 50.0	43	-	-	-
31	БПВЛА 70.0	122	-	-	-
32	БПВЛА 95.0	144	-	-	-

Note: The tabulated data do not include the lengths of wires supplied by the Manufacturer complete with the equipment items such as: the cannon mounts, some of the radio and radar sets, etc.

SWITCHING, CONTROL AND PROTECTION ARRANGEMENTS

Electric power is distributed in the aircraft electric system by means of distributing arrangements (boards, panels and boxes) provided with switching, control and protection appliances of various kinds.

For the layout of electric control boards, panels and junction boxes see Fig.1.

To reduce the weight, all the boards, panels, boxes and the like equipment items are made of thin sheet material, with the thickness usually ranging from 0.6 to 0.8 mm. With the same purpose widely used in the constructions of electric units are magnesium alloy sheets, shaped members, cast brackets, etc.

Part of nameplate, label and standard inscriptions on the aircraft is made in luminous compound of two colours: orange luminous mass for inscriptions of emergency character, and green mass for all the other inscriptions.

Used for switching operations on the D.C. electric circuit are various switches and change-over switches. For switching operations on the A.C. electric circuit of 115 V, 400 c.p.s. use is made of toggle switches, type 2ПП-250.

For the list of switches and change-over switches used in the aircraft, as well as for their major technical characteristics refer to Table 3.

Due to the fact that the switches and change-over switches are neither moist nor dust-proof by themselves those switches which are installed at water-hazardous areas are provided with special rubber protectors which keep moisture off the contact sections of the switches; the protectors are fitted over the switch knobs and levers.

Apart from the OFF-ON and selector switches, the electrical system is provided with buttons of 5K and 20AK types; these buttons are rated for voltages up to 30 V, the maximum operational current for 5K buttons being up to 5 A, and for 20AK buttons - up to 20 A.

Table 3

Nos	Description	Type	Rated voltage, V	Maximum operating current, A
1	2	3	4	5
1	Switch, toggle	В-45	28	35
2	Switch, change-over, toggle	ПП-45	28	35
3	Switch, push-type	ВН-45М	28	35
4	Switch, change-over, push-type	ПН-45М	28	35
5	Switch, change-over, toggle, with neutral position	ПНН-45	28	35
6	Switch, toggle, two-pole	2В-45	28	20
7	Switch, change-over, toggle, two-pole	2ПП-45	28	20
8	Switch, push-type, two-pole	2ВН-45	28	20

1	2	3	4	5
9	Switch, change-over, push-type, two-pole, with neutral position	2ПН-20	28	2.
1.	Switch, change-over, with neutral position	2ППН-45	28	20
11	Switch, change-over, toggle, three-pole, with neutral position	3ППН-45	28	20
12	Switch, change-over, toggle, four-position, double-push-type, with neutral position	П2НПН-45	28	35
13	Switch, change-over, toggle, two-pole	2ПП-250	250	2
			120	5

Employed in the electric circuits of the aircraft automatic systems, remote control systems, as well as in the systems of blocking and signalization in the function of terminal and line limiters, blocking contacts and operating buttons are miniature switches of series ВК-140 and КВ-6, and limit switches, type ВК-44. The above switches are used only in the D.C. circuits.

For the list of the miniature switches used in the aircraft and their main technical characteristics see Table 4.

Table 4

Nos	Description	Type	Rated voltage, V	Maximum operating current, A
1	2	3	4	5
1	Switch, change-over	ВК1-140	28	15
2	Switch, change-over	ВК2-140	28	15

1	2	3	4	5
3	Switch, change-over	ВК2-140Б	28	15
4	Switch, disengaging	ВК2-141В	28	15
5	Switch, engaging	ВК2-142А-1	28	15
6	Switch, engaging	ВК2-142В	28	15
7	Switch, engaging	ВК2-142Г	28	15
8	Switch, limit	ВК-44	28	10
9	Switch, disengaging	КЗ-6-1	28	10
10	Switch, engaging	КЗ-6-2А	28	10

Apart from the above ON-OFF switches, change-over switches and buttons, the following switching and control equipment is used in the aircraft:

(a) contactors, types К-25А, К-50Д, К-100Д, К-250, К-300Д, К-400Д and К-600Д; these contactors are designed for remote on-off switching operation on the aircraft D.C. circuits (contactors, type К-50Д, are installed in the A.C. circuits, too);

(b) relays, types МР-2, РТ-40, РД-12 and РЭЗ-45, which are also used for remote on-off switching operations on the D.C. circuits;

(c) miniature relay switches, types РП-2, РП-3 and РП-6, which are designed for use in D.C. circuits with voltages up to 30 V and in single-phase A.C. circuits of the automatic remote blocking and signalization control systems designed for 208 (or 120) volts at a frequency of 400 c.p.s.;

(d) miniature relays, type РПМА, designed for use in the circuits preventing D.C. power sources from outting-in in case polarity is wrongly applied;

(e) selecting contactors, types КП-400Д and КП-200Д, which are designed for automatic re-connection of the dual supply circuit from the normal supply circuit to the emergency one;

(f) terminal blocks are designed for connection and distribution of electric power.

For electric circuit protection in the aircraft use is made of the following protecting arrangements:

(1) circuit breakers;
(2) fuses, glass, type СП;
(3) fuses. delayed-action, type ИП;
(4) high temperature fuses, type ТП.

The circuit breakers are used for automatic disconnection of the power consumers, and for protection of supply wires in case of hazardous overloads and shortings in the electric circuit.

The operation of a circuit breaker is based on the property of a bimetallic strip to camber as a result of its heating by the current which flows through it (Fig.2). The construction of circuit-breakers makes it possible to connect and disconnect the circuit manually. In this case they function as ordinary single-pole switches. However, the majority of the circuit breakers installed in the aircraft functions as protectors, and, therefore, prior to the flight and in the course of flying the circuit breakers should be always ON.

The circuit breaker is turned on manually, with the aid of the operating lever. The circuit breaker is thrown off in case of overloads and short-circuiting automatically. If it is necessary to place the circuit breaker off at rated load, this will be done manually.

The circuit breakers are installed in D.C. circuits with a rated voltage of 28 V, their location providing easy access during the flight.

The following types of circuit breakers are used in the aircraft: АЗС-2, АЗС-5, АЗС-10, АЗС-15, АЗС-20, АЗС-25, АЗС-30, АЗС-40 and АЗС-50 (the figure identifies the rated current of a given circuit breaker).

Fuses (fuse links), types СП, ИП and ТП, are designed for protecting electrical equipment and circuits against short-circuit currents and continuous, although small, overloads. The delayed-action fuses ensure normal protection and at the same time withstand short-time

current shocks (three-fold and six-fold current increases) which may occur during the operation of certain electrical units.

Fuses, type СП, are used in A.C. circuits and also in D.C. circuits characterized by constant loading conditions, and at points which are inaccessible in flight.

Fuses, types ИП (Fig.3) and ТП, are provided in the electric actuator feed circuits; they are also used for group protection of the electric power distribution system and for generator protection.

Fuses, types СП, ИП and ТП, are mounted on the aircraft in various-kind boxes, and are available in the following ranges: СП-1а, СП-2а, СП-5, СП-10, СП-15, ИП-10, ИП-15, ИП-5, ИП-30, ИП-35-2, ИП-50, ИП-75, ИП-100, ИП-150, ИП-200, ИП-250, ТП-400, ТП-600 and ТП-900, the figures designating current rating for each particular fuse.

Section 2

POWER SOURCES AND POWER DISTRIBUTION SYSTEM

1. D.C. POWER SOURCES

Generators

The generator, type ГСР-18000, is a shunt-wound D.C. machine with a wide operating speed range which makes it possible to pick up the generated voltage under all the engine operating conditions, beginning with the low throttle duty.

Two generators, type ГСР-18000, are installed on each engine. They are driven by the engine shaft through the gear boxes with the reduction factor of 2.

The direction of the generator rotation is left-hand (counter-clockwise), as viewed from the generator drive side.

The generator armature is driven with a torsion shaft which smooths down dynamic loading bumps applied to the armature. Provision of the torsion shaft facilitates the generator-to-engine coupling (Fig.4).

Main Technical Data of Generator, Type TCP-18000

Rated power at 30 V ..... 18,000 W
Rated voltage ..... 28.5 V
Load current rating ..... 600 A
Speed range ..... 3800 to 9000 r.p.m.
Operating mode ..... continuous
Type of brushes used MTC-9 (MTC-7X)
Brush dimensions ..... 8x20x26 mm
Weight of generator ..... 41.5 kg

The usable operating conditions of the generator are as follows:

Speed	Load, A	Time	Remarks
3800 - 9000	600	Unlimited	With engine operating in low throttle duty (at 3400 r.p.m.), 400 A can be picked up continuously from generator
4250 - 8200	750	1 min.	
4800 - 8200	900	10 sec.	
5600	1080	2 sec.	
8200	1200	2 sec.	

The generator can be operated for not longer than 8 minutes at 9300 r.p.m. and at a load of 100 to 600 A during the engine operation in one single flight. The above technical data are true for the generator cooled by the onrush stream of the free air. The generator can be also used on the ground (i.e. without air cooling). In this case a current of 200 A can be picked up from the generator operating at 3400 r.p.m. during 20 minutes.

Apart from this the generator can be operated in an emergency duty; during this kind of operation it is allowed to overload the generator with a current of 660 A for 20 minutes at a speed of 4250 to 8200 r.p.m.

After operation in the emergency duty upon return to the base the generator should be removed from the aircraft and subjected to thorough inspection, and, if necessary, to repair.

The generators are cooled through the air scoops located in the bifurcating nose section of the air duct, one air scoop in each engine nacelle. Each air scoop is connected by means of an air pipe with the air inlet sleeves of the two generators.

The above cooling system ensures that at least 235 litres of air are forced through the generator per second.

Storage Battery

The aircraft uses a starter-type storage battery 12-CAM-55 which consists of two half-batteries, type 6-CAM-55, which are connected together in series.

Main Technical Data of Storage Battery

Rated voltage ..... 24 V
Capacity at discharge current of 11 A:
before 100th engagement ..... 53 amp-hrs
between 101th and 170th engagements ..... 48 amp-hrs
Maximum discharge current permissible ..... 1350 A
Weight ..... 55 kg

Each half-battery, type 6-CAM-55, is housed in a heated container (Fig.5).

The container is provided with an electric heater which consists of two heating strips. Each heating strip is nothing but heating element 4 placed between two layers of glass

fabric; the heating element consists of four series lengths of constantan wires with a total resistance of 4.1 ohms.

The strips of each heater are connected together in series, while the heaters of the two containers are connected in parallel.

Provided in the container for automatic temperature control is bimetallic thermal switch 6 (Index 777B) which operates to disconnect the heaters as soon as a temperature of plus 70^{+10}°C is reached. The thermal switch is series-connected to the minus circuit of the heating elements.

The battery container heaters can be energized only from a ground power source connected to the ground power supply receptacle.

The heater switch is located above the left container, and the protecting fuse of the heater (fuse, type СП-10) is installed in the storage battery junction box.

The containers are located in the non-pressurized section of the fuselage between frames Nos 17 and 19, both on the starboard and port sides.

Provided inside the container is fixed cast base 15 with guide rails 16 which carry removable sliding sledges 22. Mounted on the sledges and secured to them by means of hold-down straps 20 is half-battery 3 fitted into special metal bath 21. The bath is lined from inside with heat insulating material, mark АТИМ, which is glued to the bath. Put on the top part of each half-battery is a special case made of АТИМ heat insulating material. Both the bath and the case protect the container structure against corrosion by the battery electrolyte in case of its splashing or leakage. With the same purpose the inner surface and parts of the container are coated with acid-resistant paint before the heat-insulating material is applied.

The chamber of each battery container communicates with the atmosphere through a gas-discharge tube which is designed to expel electrolyte vapours from the container to the atmosphere.

The half-batteries are connected together and to the aircraft mains with the aid of floating pin-type contacts; contact pins 12 are secured in the fixed base, and contact sockets - on the carriages. Connected to the sockets by means of wires 1 and 19 are the terminals of the half-battery, and connected to the pins are the wires of the aircraft mains.

The battery-aircraft mains connection diagram is shown in the Schematic Circuit Diagram of D.C. Supply Sources.

D.C. Power Distribution System

The entire D.C. power distribution system (the aircraft mains) consists of three separate circuits. They are:

(1) normal supply circuit;
(2) emergency supply circuit;
(3) dual supply circuit.

As a rule, the normal supply circuit connects all the four generators (I - IV), and the storage battery (Fig.6). The generators and the battery are engaged separately and therefore may be connected to the normal supply circuit in any combination: for instance, one generator and the battery, two generators, three generators and the battery, and so on.

Connected to the emergency supply circuit can be only one of the inboard generators (the second or the third one) plus the storage battery.

The dual supply circuit is automatically connected, by means of selecting contactors of КП type, either to the normal supply circuit if it is energized, or to the emergency supply circuit if the normal supply circuit is de-energized (Figs 6 and 7).

The above mentioned contactors are installed in the following points of the aircraft:

(a) two contactors, type КП-400Д - on the engine nacelle distribution boards (one - on the left, and the other - on the right panel);

(b) one contactor, type КП-200Д - in the fuel pump junction box at frame No.49;

(c) one contactor, type КП-400Д - in the dual supply circuit junction box at frame No.17;

(d) one contactor, type КП-200Д - in the dual supply circuit junction box at frame No.6.

From the three power supply circuits mentioned above power is fed to the following three groups of power distribution bus bars:

(1) normal supply bus bars which are connected only to the normal supply circuit;

(2) dual supply bus bars which are connected to the dual power supply circuit;

(3) triple supply bus bar which is usually connected, through a special change-over switch, to the dual power supply circuit, and, consequently, is fed either from the normal power supply circuit or from the emergency power supply circuit. In case of damage to both the normal and emergency power supply circuits this bus bar is manually re-connected for direct supply from the storage battery.

The distribution bus bars are not connected to the emergency power supply circuit directly.

The normal power supply bus bars feed those power consumers which are required for normal operation of the aircraft but which are not required in case of emergency. Such power consumers are: the heaters, de-icers, autopilot, fans, some lighting equipment, etc.

The dual power supply bus bars feed those consumers which make it possible to fulfil the mission and return to the base even if the normal supply circuit fails. These power consumers are: the bombing equipment, fuel pumps, flight control and navigating instruments, landing flap actuators, L.G. warning system, some items of lighting equipment, etc.

The triple power supply bus bar (the bus bar feeding the instruments from the storage battery when the aircraft mains are de-energized) feeds only those power consumers of vital

importance which make it possible to perform a forced landing. These power consumers are: the main gyro horizon set, pilot's bank-and-turn indicator, upper left ТП-156 pitot tube heater, interphone channel No.1, emergency ultra-violet illumination of the pilots' and the navigator's compartments, automatic brake control unit, drag chute system, blow-off band control system, CO_2 bottle control system, fuel shut-off and cross-feed valve control system, and radio set, type РСИУ-3М.

The feeders of the top emergency bomb dropping system and of the transponder destructor, as well as the engine in-flight starting system are connected directly to the storage battery and can be engaged at any moment without any additional connection and selection of power supply sources.

Thus, to ensure power supply to the consumers even in case of failure of separate sections of the aircraft electric supply mains the D.C. power distribution system is so designed that it can be used in three operating duties:

(1) normal duty;

(2) emergency duty;

(3) with only vital-importance consumers connected to the storage battery ("de-energized mains" duty).

Normal power supply duty. In the normal supply duty the circuit connects, as a rule, all the four generators and the storage battery.

In such a case energized are all the normal supply bus bars, the dual supply bus bars, and the triple supply bus bar.

The ON-OFF and change-over switches on the generator control panel located by the radar operator (Fig.8) should be placed to the following positions:

(1) the switches of the four generators and the switch disconnecting the battery from the normal supply circuit should be ON (ВКЛЮЧЕНО);

(2) the storage battery change-over switch should be in the NORMAL (НОРМАЛЬНО) position;

(3) the emergency supply circuit switch - OFF (ВЫКЛЮЧЕНО);

(4) the change-over switch connecting the generators to the emergency supply circuit (bearing the inscription FROM GENERATOR) (ОТ ГЕНЕРАТОРА) should be placed to the LEFT No.2 (ЛЕВЫЙ № 2) position;

(5) the change-over switch bearing the inscription CONNECTION OF EMERGENCY INSTRUMENTS TO BATTERY (ВКЛЮЧЕНИЕ АВАРИЙНЫХ ПРИБОРОВ НА ПИТАНИЕ ОТ АККУМ) should be OFF;

(6) the switch bearing the inscription GROUND SUPPLY (АЭРОДРОМНОЕ ПИТАНИЕ) should be OFF.

Note: The storage battery blocking switch is rigidly connected to the common generator switch bar. This means that if any single generator switch is ON, the generator blocking switch is also in the ON position.

In case of failure of part of the generators, it is possible to connect three, two and even one generator plus the storage battery to the normal power supply circuit. When three generators and the storage battery are connected to the normal power supply circuit, there are no limitations for the number of the consumers connected to the circuit. If two generators and the storage battery are connected to the normal supply circuit, engaged at a time may be only the cannon system with continuously operating power consumers, or the tail unit de-icers with continuously operating power consumers. It is prohibited to simultaneously engage the cannon system and the tail unit de-icer system. If only one generator and the storage battery are connected to the normal supply circuit, the power consumers can be connected only in such a combination which ensures that the total load does not exceed 600 A.

Emergency duty. In case of failure of the normal supply circuit it is possible to disengage it and to employ the emergency supply circuit.

During the emergency duty flight the circuit will connect one of the two generators (the second generator on the left engine, or the third generator on the right engine) plus

the storage battery. Energized will be the emergency supply circuit, the dual supply bus bars and the triple supply bus bar. In this case the normal supply circuit will be disconnected and de-energized.

To change from the normal to the emergency duty:

1. Operate the emergency generator disconnecting lever to disconnect all the four generators and the storage battery from the normal supply circuit.

2. Turn on the emergency supply circuit switch. This action will result in the following (Fig.9):

(a) the storage battery will be disconnected from the normal supply circuit;

(b) the four main differential undercurrent relays, type ДМР-600, will disconnect all the generators from the normal supply circuit;

(c) generator No.2, by means of its additional relay, type ДМР-600, will be connected to the emergency supply circuit.

When sure that the emergency supply circuit and generator No.2 operate normally (referring to the ammeter and the voltmeter), throw the storage battery change-over switch to the EMERGENCY (АВАРИЙНО) position. Thereby the storage battery will be connected for buffer operation with the generator to the emergency supply circuit.

In case left generator No.2 or its circuit is faulty, the generator selector (change-over switch) should be re-set to the RIGHT No.3 (ПРАВЫЙ № 3) position. In this position connected to the emergency supply circuit instead of generator No.2 of the left engine will be inboard generator No.3 of the right engine.

In the emergency duty those power consumers will be energized which are connected to the dual supply bus bar (See Table 5) and to the triple supply bus bar (See Table 6). When using this duty, the flying time is not limited.

Table 5

Power Consumers Connected to Dual Supply Bus Bar

Nos	Description	Type of protector	Feeder marking
1	2	3	4
1	Fuel flow automatic control unit, left	A3C-5	АГ
2	Fuel flow automatic control unit, right	A3C-5	АД
3	Emergency bomb release control	A3C-5	ВА
4	Combat bomb release power supply	A3C-15	ВБ
5	Arming system	A3C-10	ВВ1
6	ARMED emergency bomb release system	A3C-10	ВВ2
7	Fuze circuits, left front	СП-5	ВВа
8	Fuze circuits, right front	СП-5	ВВб
9	Fuze circuits, left rear	СП-5	ВВв
10	Fuze circuits, right rear	СП-5	ВВг
11	Emergency bomb release control relay	A3C-2	ВД
12	Emergency bomb release control relay	A3C-2	ВЕ
13	Combat bomb release blocking relay	A3C-2	ВЖ
14	Combat bomb release blocking relay	A3C-2	ВМ
15	Emergency bomb release power supply	ИП-50	ВН
16	Sight power supply	A3C-15	ВП
17	Bomb release variant box power supply	A3C-5	ВР
18	Rear bomb rack disconnecting relay	A3C-2	ВФ
19	Starting system power supply	A3C-25	+3

1	2	3	4
20	Left engine air valve	A3C-5	1ЗА
21	Left engine starting system	A3C-15	1ЗВ
22	Left engine starting control	A3C-5	1ЗН
23	Right engine air valve	A3C-5	2ЗА
24	Right engine starting system	A3C-15	2ЗВ
25	Right engine starting control	A3C-5	2ЗН
26	Standby inverter, type ПО-4500	ТП-400	ИЛ
27	Fuel pump of left tank No.19	ИП-15	МБа
28	Fuel pump of left tank No.16	ИП-50	МБб
29	Fuel pump of left tank No.10	ИП-50	МБв
30	Fuel pump of left tank No.2	ИП-50 and ИП-50	МБг and МБр
31	Fuel pump of right tank No.3	ИП-75	МБд
32	Fuel pump of left tank No.4	ИП-75	МБе
33	Fuel pump of right tank No.5	ИП-50 and ИП-50	МБж and МБо
34	Fuel pump of left tank No.6	ИП-50	МБз
35	Fuel pump of right tank No.6	ИП-50	МБи
36	Fuel pump of right tank No.10	ИП-50	МБк
37	Fuel pump of right tank No.10	ИП-50	МБл
38	Fuel pump of right tank No.19	ИП-15	МБм
39	Air position indicator, type НИ-50Б	A3C-5	АК
40	Flap actuator, electric motor No.1	ИП-150	МЩ
41	Flap actuator, electric motor No.2	ИП-150	МУ
42	Ultra-violet illumination of pilot's instrument panel and upper (overhead) electric control board	A3C-2	ОУ
43	Standby gyro horizon set	A3C-5	ПВ
44	Co-pilot's gyro horizon set	A3C-5	ПГ
45	Three-pointer indicator of right engine, type ЭМИ-3Р	A3C-2	ПД

1	2	3	4
46	Fuel quantity gauge of left engine tanks	A3C-2	ПЕ
47	Fuel quantity gauge of right engine tanks	A3C-2	ПЖ
48	Fuel flow gauge of left engine tanks	A3C-2	ПЗ
49	Fuel flow gauge of right engine tanks	A3C-2	ПИ
50	Fuel pressure gauge	A3C-2	ПЛ
51	Three-pointer indicator, type ЭМИ-3р, of left engine	A3C-2	ПМ
52	Bank-and-turn indicator of co-pilot	A3C-2	ПУ
53	Flap position indicator, free air temperature indicator	A3C-2	ПЩ
54	Range-finder, type СД-1	A3C-2	РД
55	АРК-5 radio compass No.1	A3C-2	РК
56	АРК-5 radio compass No.2		РЛ
57	Instrument landing system	A3C-10	РМ
58	Transponder	A3C-5	РО
59	Control of bombsight, type РБП-4	A3C-20	РП
60	Antenna duplexer of radar altimeters, types РВ-2 and РВ-17М	A3C-2	РЩ
61	Left tank group fuel pump operation warning system	A3C-2	СБ
62	Bombing system warning	A3C-5	СВ
63	Right tank group fuel pump operation warning system	A3C-2	СД
64	Hydraulic system warning	A3C-2	СГ
65	Cabin sound signalization system	A3C-2	Сз
66	Airspeed (mach) limit warning	A3C-2	СМ
67	Front cabin pressure drop warning system	A3C-2	СО

1	2	3	4
68	Left tank group fire warning system	A3C-15	СП
69	Right tank group fire warning system	A3C-15	СУ
70	Pattern bombing signal lamps	A3C-15	СФ
71	Colour flare bomb normal release system	A3C-20	СХ
72	Colour flare bomb door signalization and release control blocking system	A3C-2	СЦ
73	Colour flare bomb emergency release system	ШП-30	СЧ
74	Colour flare bomb station status indicator	A3C-2	СЦЗ1
75	Landing gear warning system	A3C-2	СШ
76	Colour flare bomb emergency release control	A3C-2	СЩ
77	Heaters of ТП-156 pitot tubes of co-pilot, radar operator, radio operator, and heaters of НМ-50 air position indicator and ОПБ-11р sight	A3C-10	ТП
78	Control of standby pumps of tanks No.16	A3C-2	УБд
79	Control of standby pumps of tanks No.6	A3C-2	УБе
80	Remote-indicating compass, type ДГМК-7	A3C-2	УД
81	Emergency drainage	A3C-2	УЖ
82	Control of standby inverter, type ПО-4500	A3C-2	УИ21
83	Normal control of bomb bay doors	A3C-5	УЛ
84	Emergency control of bomb bay doors	A3C-5	УП

1	2	3	4
85	Flap control, motor No.2	A3C-5	УУ
86	Fuel flow control	A3C-2	УЧ
87	Flap control, motor No.1	A3C-5	УЩ
88	Control of first-group fuel pumps of left engine	A3C-5	$У_{31}$
89	Control of first-group fuel pumps of right engine	A3C-5	$У_{32}$
90	Control of second-group fuel pumps	A3C-5	$У_{33}$
91	Control of third-group fuel pumps	A3C-5	$У_{34}$
92	Control of fourth-group fuel pumps	A3C-5	$У_{35}$

Table 6

Power Consumers Connected to Triple Supply Bus Bar and Directly to Storage Battery Bus Dar

Nos	Description	Type of protector	Feeder marking
1	2	3	4
1	Emergency ultra-violet illumination of front cabin and illumination of КИ-12 compasses	A3C-5	ОА
2	Gyro horizon set, main	A3C-5	ПВ
3	Pilot's bank-and-turn indicator	A3C-2	ПП
4	Interphone channel No.1	A3C-5	РА1
5	Interphone call boxes	A3C-2	РА20
6	Heaters of pitot tube of pilot and navigator, and ССН-3 heater	A3C-5	ТН
7	Automatic brake control unit	A3C-10	АУ
8	Engine blow-off band control system		

1	2	3	4
9	CO_2 bottle control system	A3C-10	УЕ
10	Drag chute control system	A3C-5	УС
11	Control of shut-off and cross-feed valves	A3C-5	МБ
12	Radio set, type РСИУ-3М	A3C-5	РЗ
13	Transponder destructor	No protection	ЗА31
14	Bomb release, with mains de-energized	No protection	ЗС
15	In-flight engine starting	No protection	ЗП

Note: The first seven power consumers are connected to the bus bar which is energized from the storage battery through a fuse, type ИП-35. The total current consumed by these power consumers does not exceed 20 A.

In case of failure of the emergency power supply circuit it is necessary to select the "de-energized mains" duty.

De-energized mains duty. In this duty the entire mains are de-energized and the storage battery will supply only that group of power consumers which is absolutely necessary for the flight continuation (See Table 6). For this duty the switches on the radar operator's control panel (Fig.8) are placed to the following positions:

1. The change-over switch bearing the inscription CONNECTION OF EMERGENCY INSTRUMENTS TO BATTERY (ВКЛЮЧЕНИЕ АВАРИЙНЫХ ПРИБОРОВ НА ПИТАНИЕ ОТ АККУМУЛЯТОРОВ) should be ON.

2. The emergency supply circuit switch should be OFF.

3. The storage battery switch remains in the OFF position.

4. The switches of the four generators and the battery blocking switch should be in the OFF positions.

WARNING: The storage battery, type 12-CAM-55, ensures power supply for the consumers specified in Table 6 during not longer than two hours.

The reliability and endurance of the power supply system are improved due to the following:

(a) the normal power supply mains are laid along both port and starboard sides of the fuselage and the cables are interconnected at frames Nos 17 and 69 (See the Diagram, Fig.7) by means of aluminium wire jumpers, and in the area of frame No.42 - by means of a rubber-encased bus bar;

(b) the normal supply mains are laid in the top part of the fuselage, while the emergency supply line is laid in the middle part of the fuselage; this lessens the probability of simultaneous breakage of both mains;

(c) certain sections of the mains are provided with group (selective) protection, i.e. with delayed-action fuses; this considerably lessens the probability of failure of the entire mains.

Functioning of Generators and Storage Battery

The four generators, type ГСР-18000, and the storage battery, type 12-CAM-55, operate in parallel, i.e. they are connected to a common plus bus bar (See the Diagram, Fig.9).

Each generator operates in conjunction with the following equipment:

(a) carbon voltage regulator, type РУГ-82, with extensis resistor, type ВС-20, capacitor, type КБМ-31, and stability transformer, type ТС-8;

(b) differential undercourrent relay, type ДМР-600;

(c) ballast resistor, type БС-18000.

The generators and the storage battery are connected to the normal or emergency power supply circuits, and the storage battery is engaged for de-energized mains power supply of instruments with the aid of ON-OFF and change-over switches

which are mounted on the generator control panel of the radar operator (See Fig.8).

Voltage Regulator, Type РУГ-82

The carbon voltage regulator, type РУГ-82, automatically maintains the generated voltage stability under variable speed and loading conditions and ensures uniform distribution of load between the parallel-operating generators.

Each ГСР-18000 generator is provided with its own voltage regulator (Fig.10); the voltage regulators are mounted on special cast brackets on the outer side of the non-pressurized section of the fuselage between frames Nos 36 and 37 below the top hatches of the engine nacelles. The two voltage regulators installed on the port side service the left engine generators (first and second generators). The two other voltage regulators installed on the starboard side operate with the generators (third and fourth) of the right engine.

The operation of the voltage regulator is based on the principle of changing the resistance of the generator field winding by means of a carbon pile (consisting of separate carbon rings) which is series-connected to the field winding circuit (See the Diagram in Fig.9).

Main Technical Data of Voltage Regulator, Type РУГ-82

The rated voltage maintained by the regulator is 28.5 V.

Voltage fluctuation (surge) within the generator speed range of 4000 to 9300 r.p.m. and ambient temperature varying from minus 60 to plus 50°C, at up to 15,000 m. above sea level, and with the generator loading changing from zero to rated, does not exceed 3.5 V. With the generator speed changing within 3300 to 3900 r.p.m., the other conditions remaining the same as specified above, the voltage surge amounts to 3.8 V.

The regulator ensures voltage control under conditions of the generator current variations within 2 to 15 A.

The maximum power dispersed in the carbon pile is 170 W; the operating duty of the voltage regulator is continuous.

The extension resistor, type ВС-20, operates in set with the carbon voltage regulator, type РУГ-82; the resistor provides additional adjustment of the generator voltage level and equalizes the voltages and currents of the parallel-operating generators.

All the four extension resistors are mounted on the radio operator's generator control panel (See Fig.8).

Voltage control is effected by regulating the resistance in the circuit of the regulator working winding.

Main Technical Data of Resistor, Type ВС-20

Rheostat resistance	not less than 10 ohms
Rated current	0.8 A
Voltage level control limits	plus 1.5 V and minus 3 V
Mode of operation	continuous

The capacitor, type КБМ-31, rated for 4 μF is connected to the plus wire of the РУГ-82 voltage regulator to cut down the level of radio interference produced by the operating regulator.

The stabilizing transformer, type ТС-8, operates in conjunction with the РУГ-82 voltage regulator and is designed to ensure stability of the regulator operation under transient operating conditions of the generators. Each stability transformer operates in set with its respective voltage regulator. All the four ТС-8 transformers are mounted on common brackets with the voltage regulators.

The differential undercurrent relay, type ДМР-600, operates automatically; its functions are:

(1) connection of the generator to the aircraft mains if the generator voltage is 0.3 to 0.7 volts higher than the mains voltage;

(2) disconnection of the generator from the mains under conditions of a reverse current of 20 to 50 A;

(3) holding the generator disconnected from the mains in case of wrong polarity of the connected wires.

The relay, type ДМР-600, consists of the following elements (See Fig.11): the contactor, differential command relay, relay РМР-2А, relay РЛ-5Б and two glazed resistors. The above elements are mounted on a common base plate and are contained in a common housing (less the contactor).

There are six ДМР-600 relays on the aircraft altogether; four of them are principal relays which connect the generators to the normal power supply circuit, and the other two relays are additional: they connect the second or the third generator to the emergency supply circuit (See the Diagram, Fig.9). The relays, type ДМР-600, are installed on the distribution panels of the left and right engine nacelles, three relays on each distribution panel (Fig.12). The distribution panels are mounted on the outer side of the non-pressurized section of the fuselage between frames Nos 41-43, next to the brackets carrying the РУГ-82 voltage regulators.

Main Technical Data of Relay, Type ДМР-600

Supply voltage	$28.5^{+1.5}_{-8.5}$ V
Rated current flowing through contactor contacts	600 A
Reverse current at opening	20 to 50 A
Mode of operation	continuous

The ballast resistor, type БС-18000. The minus wires of the generators, type ГСР-18000, are connected to the airframe through special ballast resistors, type БС-18000. These resistors are mounted on the fuselage plating in the

area of frame No.44: two resistors on the starboard wall and the other two - on the port side wall (Fig.13). The ballast resistors, type БС-18000, take part in the parallel operation of the generator and ensure the operation of the ДМР-600 differential undercurrent relay under reverse current conditions. The resistance of the ballast resistor is 0.000715 ohm.

Connecting the Power Supply Sources

The procedure of connecting the ГСР-18000 generators and the 12-САМ-55 storage battery to the normal and emergency supply circuits, as well as employment of the battery as an emergency power supply source have been described earlier under the heading "D.C. Power Distribution System".

Engagement of the generator switches, type 2В-45 (See the Diagram, Fig.9) results in the operation of the РПР-2 relay which is a component part of each differential undercurrent relay, type ДМР-600. The РПР-2А relay 10 connects, through its contacts, the shunt winding of command relay 9; if the generator voltage exceeds the mains voltage, relay 9 operates to energize the winding of contactor 6 which, in its turn, connects the generator to the aircraft mains.

The closed position of switch 42 which blocks the storage battery is the preparatory position for connecting the battery to the normal supply circuit.

When storage battery change-over switch 33 is placed to NORMAL (НОРМАЛЬНО), the field winding circuit of contactor 28 becomes closed, and the contactor connects the storage battery to the normal supply circuit. The above ON-OFF operations ensure normal operating conditions, with emergency circuit switch 25, triple supply bus bar selector switch 34 (the switch connecting the emergency instruments to the battery), and ground supply switch 31 open. The power supply sources are disconnected in the reverse order, i.e. the storage battery is disconnected first, and then are the generators.

In case of faults or short circuiting in the normal power supply mains, use should be made of the generator emergency disconnecting switch bar to simultaneously open all the four generator switches, type 2В-45, and switch 42 which blocks the battery from the normal supply circuit. The storage battery gets disconnected from the normal power supply circuit as the minus circuit of the field winding of contactor 28 is broken by switch 42. All of the four main differential undercurrent relays, type ДМР-600, disconnect their respective generators from the normal power supply circuit, as opening the generator switches results in de-energizing relays, type РПР-2А.

When closing emergency circuit switch 25 depending on the position of change-over switch 26 bearing the inscription FROM GENERATOR (position LEFT (ЛЕВЫЙ) No.2 or position RIGHT (ПРАВЫЙ) No.3), РП-6 blocking relay 54 or 55 of the second or third generator is tripped. At the same time the РПР-2А relay of the additional ДМР-600 relay is energized to connect generator No.2 or generator No.3 to the emergency power supply circuit.

Actuation of the contacts of the blocking relay, type РП-6, 54 or 55 results in the following:

1. The field winding supply circuit of the РПР-2А relay of the main differential undercurrent relay, type ДМР-600, is additionally broken although the differential relay has already disconnected the given generator from the normal power supply circuit when the generator switches were open;

2. The parallel operation winding circuit of the РУГ-82 voltage regulator of the generator connected to the emergency supply circuit gets broken, too;

3. The field winding supply circuit of К-300Д contactor 28 is broken additionally although the contactor disconnects the storage battery from the normal power supply circuit at the moment switch 42 opens;

4. The field winding circuit of К-300Д contactor 27 is prepared for connecting the storage battery to the emergency power supply circuit.

Upon closure of switch 25, provided that the emergency power supply circuit and generator No.2 (or No.3) function normally, storage battery change-over switch 33 should be placed to the EMERGENCY (АВАРИЙНО) position. This re-setting will close the field winding circuit of К-300Д contactor 27 which, while closing, will connect storage battery 47 to the emergency power supply circuit for buffer operation with the generator, thereby ensuring the emergency duty operation.

If, through one reason or another, the normal-to-emergency duty change-over procedure is violated, the blocking relays, type РП-6, 54 and 55 will perform the following blocking operations:

(a) the relays will render it impossible for the storage battery to be connected to the emergency supply circuit until the second or the third generator is connected to this circuit;

(b) automatic disconnection of the storage battery from the normal supply circuit when the second or the third generator is connected to the emergency supply circuit;

(c) automatic disconnection of the second or third generator from the normal supply circuit when it is connected to the emergency supply circuit, with the 2В-45 switches of these generators closed;

(d) disconnection of the РУГ-82 voltage regulator which operates in conjunction with the generator connected to the emergency supply circuit from the generator parallel operation system.

As stated above, the 12-САМ-55 storage battery is connected either to the normal or to the emergency supply circuit by means of respective contactors, type К-300Д, installed in the storage battery junction box (Fig.14). These contactors are controlled from the radar operator's generator control panel with the aid of the STORAGE BATTERY (АККУМУЛЯТОР) change-over switch, type ППН-45, which has three positions: NORMAL (НОРМАЛЬНО), EMERGENCY (АВАРИЙНО) and OFF (ВЫКЛЮЧЕНО) as shown in Fig.8.

To select the de-energized mains operating duty when only the instruments of vital importance are connected to the

storage battery, the CONNECTION OF INSTRUMENTS TO BATTERY change-over switch provided on the generator control panel at the radar operator's station should be closed. As a result (See the Diagram, Fig.9) the following happens:

1. The triple supply bus bar is disconnected from the dual supply circuit and is connected directly to the storage battery through a delayed-action fuse, type ИП-35-2, installed in the storage battery junction box (Fig.14).

2. The storage battery is automatically disconnected from the normal and emergency supply circuits if it has been connected to either of them.

3. Irrespective of the pilot's desire the emergency (standby) gyro horizon set becomes energized.

Ground Power Supply Receptacle

For electric supply at aircraft parking and at engine starting the aircraft is provided with ground power supply connector the plug of which is mounted in the nosewheel well at frame No.16, port side.

The plug and its mating detachable receptacle have three pins and three sockets. The two power pins are thicker and longer than the third pin which is used for guiding. This construction ensures that the power contacts are energized only upon complete mating. This eliminates the probability of burned power contacts.

When the ground power supply receptacle is connected, РП-2 blocking relay 39 (See Fig.9) operates to disconnect the aircraft storage battery from the normal supply circuit; second РПП-А relay 40, with contacts 1 and 2 normally closed, prepares the circuit for engagement of К-400Д contactor 32. The К-400Д contactor operates only upon closure of switch 31 mounted on the radar operator's generator control panel; when actuated, this contactor connects the ground power supply source to the aircraft mains.

РПП-А relay 40 also serves to prevent from connecting the ground supply source of wrong polarity: for this purpose the relay is provided with a selenium valve.

In case of wrong polarity of the ground power supply source this relay operates to open normally closed contacts 1 2 and thereby de-energizes the winding of contactor 32 which does not allow to connect the ground power supply source to the aircraft mains.

Relays 39, 40 and 32 (Fig.9) are installed in the storage battery junction box (Fig.14).

Control Over Power Supply Sources and Electric Mains

To effect control over the operation of the power sources (to check the intensity of current they produce) and to check the circuits for continuity and for shorting-free operation, the electrical system is provided with five ammeters. Four ammeters 36; type A-3, with the scale range of 100-0-1000 A are connected to the generator circuits, while the fifth ammeter 30, type A-2, with the scale range of 50-0-500 A is connected to the aircraft battery and ground power supply circuit.

The above ammeters are provided with extension shunts 4 and 29 located on the engine nacelle distribution panels and in the storage battery junction box.

Provided for control over the electric system power supply sources is voltmeter 38 of B-1 type rated for 30 V; this voltmeter can be connected, with the aid of selector switch 24 of П-46 type to each of the four generators, to the normal power supply circuit or to the emergency supply circuit.

When the normal supply duty is used in the flight, the voltmeter should be connected to the normal supply circuit, and when the emergency duty is used, the voltmeter should be connected to the emergency supply circuit.

All these instruments and the selector switch are mounted on the generator control panel at the radar operator's station (See Fig.8).

Additionally installed on the radar operator's generator control panel is a voltmeter, type B-1, specially used for normal supply circuit voltage measurements.

2. A.C. POWER SOURCES

For A.C. supply the aircraft is equipped with two inverters, type ПО-4500; one of the inverters is operating, and the other is standby. The inverters are engaged separately.

The inverter, type ПО-4500, (Fig.15) consists of a D.C. motor and an A.C. single-phase synchronous generator which are encased in a common housing.

The motor is of six-pole type, with mixed excitation and three commutating poles.

The synchronous generator has six fixed poles and a rotary armature with two slip rings for A.C. current commutation.

The ПО-4500 inverter set includes a carbon voltage regulator, type Р-52В, and a rheostat, type РС-4М.

The inverter control elements, but the voltage regulator and the voltage control rheostat, are housed in a box mounted on the inverter unit frame. In addition the box mounts a radio filter which localizes the radio interference produced by the operating units.

The inverter voltage is stabilized automatically by a magnetic amplifier which controls the winding of the carbon voltage regulator.

Frequency stabilization is also effected by the magnetic amplifier which feeds the motor shunt field winding which in this case is called the control winding.

Mounted on the inverter shaft on the side opposite to the fan is a centrifugal change-over switch which prevents racing and which disconnects the inverter as soon as it reaches a speed of 9700 ±300 r.p.m. and automatically engages the

standby inverter. The inverter disconnected by the centrifugal switch can be engaged repeatedly only upon pressing the return button which places the change-over switch elements in their initial position.

The inverter is designed for operation with single-wire power supply systems. The minus points of the main D.C. circuits are connected to the inverter frame.

The voltage regulator, type P-25B (Fig.16), is mounted separately on a shock panel.

The rheostat, type PC-4M, which controls the A.C. voltage supplied by the inverter to the aircraft mains is mounted on the radar operator's generator control panel (See Fig.8).

Main Technical Data of Inverter, Type ПО-4500

Rated voltage of D.C. supply	27 V ±10%
Rated power, A.C. supply, at power factor of 0.9	4500 VA
Rated voltage of A.C. supply	115 V
Rated frequency of A.C. power supply	400 c.p.s.
Number of phases	one
Current consumed from D.C. power supply	not over 280 A
Rated current of A.C. supply	39.1 A
Cooling	self-ventilated
Operational altitude range	up to 15,000 m.
Speed	8000 r.p.m.
Mode of operation	continuous
Weight with P-25B voltage regulator inclusive	not more than 47 kg

With the supply voltage fluctuating from 24.3 to 29.7 V, the load current altering from zero to the rated value, and the ambient temperature changing within plus 50°C to minus 60°C, the generator output voltage should not differ from the rated value by more than ±4%, and the frequency - by more than $^{+7\%}_{-5\%}$.

When used at altitudes up to 15,000 m. the inverter may be operated with 10 per cent current overloads during 5 minutes in every operating hour.

In both cases described above the output voltage can be brought to its rated value by operating the voltage level control rheostat.

The ПО-4500 inverters operate in set with P-25B carbon voltage regulators which are used for their regulation.

The inverters together with the voltage regulators are installed in the non-pressurized section of the fuselage between frames Nos 17 - 19, the standby inverter being on the port side, and the operating generator - on the starboard side.

For the A.C. power distribution diagram see Fig.17.

Connection of A.C. Power Sources

The inverters, type ПО-4500, are controlled from the generator control panel with the aid of a change-over switch, type ЗПНН-45, which prevents simultaneous connection of both inverters.

The operating inverter is fed with direct current through the storage battery junction box from the normal supply circuit, while the standby inverter is fed with direct current through the dual supply circuit junction box (mounted at frame No.17) from the dual supply bus bar.

For the schematic circuit diagram of A.C. supply sources see Fig.18.

When ЗПНН-45 change-over switch is placed to OPERATING (РАБОЧИЙ), current is supplied through the normally closed contacts of the centrifugal change-over switch, type ЦП, to the winding of the contactor located inside the operating inverter and connected to the plus supply line. The minus circuit of the coil of this contactor is blocked through the panel of carbon voltage regulator 9 to make it impossible for the inverter to be started with voltage regulator P-25B disconnected.

Simultaneously with the current fed to the operating inverter contactor coil, voltage is also applied through the normally closed contacts of the ЦП change-over switch to the field winding of contactor 2 (type К-50Д) which connects inverter 1 to the A.C. mains. The working winding of the second contactor which is connected to the minus supply circuit of the inverter motor is closed to the motor terminals through a special resistor which is used to control the actuating voltage of this contactor. When the contacts of the first contactor (connected to the minus supply circuit of the motor) get closed, the inverter is connected to the aircraft electric mains through a starting resistor, type ПС, which limits the starting current of the motor. The second contactor by-passes (shunts) starting resistor ПС as soon as the counter-electromotive force of the motor reaches 16 to 18 V.

The generator field winding is connected to the plus supply line next to the first contactor. The other end of the winding is connected to the minus supply line through the carbon pile of voltage regulator 9.

The inverter frequency is stabilized automatically by the magnetic amplifier, type ДО-26-170, by way of current control in the control winding of the motor. If the inverter current frequency increases due to an increased voltage in the aircraft mains or decreased loading, the current in the neutralization winding will be decreased due to the fact that the inverter frequency approaches the resonance frequency of the circuit, while the current of the magnetization winding will not be altered (in case of decreased load) or will increase (in case of increased voltage in the aircraft mains). Under these conditions due to opposite connection of the discussed windings the resultant flux of the core will be intensified which will result in increased saturation of the amplifier and in reduced inductive reactance of the amplifier. As a result, the current flowing in the motor control winding will be increased to cut down the motor speed and to reduce the inverter frequency.

In case of a lower-than-normal frequency the frequency control procedure will be a reverse one.

Automatic stabilization of the generator voltage is effected by the magnetic amplifier, type ДО-12-25, which controls the winding of voltage regulator 9 (type Р-25В). The stability transformer, type ТС-11, prevents clapping of the voltage regulator carbon pile during transient processes.

Voltage is controlled by changing the inductive reactance of the amplifier through its magnetization with the resultant flux created by the magnetization and neutralizing windings.

In case of a lower-than-normal voltage of the generator the flux produced by the collective action of these windings will be weakened, and the reactance of the magnetic amplifier will be increased, which will result in decreased current in the working winding of voltage regulator 9. Plunged by the spring the carbon pile will be compressed, and the voltage will go up. In case of a higher-than-normal voltage the control process is the reversal of that described above.

To supply the aircraft mains with alternating current on the ground, the nosewheel well in the fuselage, starboard, at frame No.16, is provided with an A.C. ground power supply junction box with a two-pin plug connector, type ШР28П2НШ7.

The A.C. ground supply is controlled with the aid of switch 5 (type В-45) mounted on the generator control panel. When closed, the switch actuates К-50Д relay 2 which connects the ground supply to the A.C. circuit of the aircraft.

Cut additionally into the К-50Д contactor control circuit is ground supply blocking relay 6 (type РП-2) which breaks the control circuit of the К-50Д contactor at the moment when one of the aircraft ПО-4500 inverters (operating or standby) is engaged.

The contactor, type К-50Д, and the relay, type РП-2, are mounted in the ground A.C. supply junction box.

For control over the A.C. voltage of 115 V, the radar operator's generator control panel (See Fig.8) mounts a ferrodynamic voltmeter, type B4-150.

Section 3

ELECTRIC POWER CONSUMERS

1. ELECTRIC SYSTEM OF FIRE-FIGHTING EQUIPMENT

The electric system of the fire-fighting equipment (Fig.19) ensures automatic and manual control of power supply to the fire cocks which, upon actuation, fulfil the following functions:

- initiate the power supply to discharge the CO_2 bottles
- connect the line running from the CO_2 bottles with the aircraft compartment in which fire has broken out.

The system incorporates the following units:

1. Two fire cock units with three cocks 3 in each unit.
2. Twenty eight overheat warning units 7 which produce alarm signals in case fire breaks out in close proximity to them.
3. Six button lamps 4 which provide fire warning and also serve as fire cock manual engagement switches.
4. PM-2 relay 2 which blocks the squib actuation circuits in the discharge bonnets of the CO_2 bottles.
5. Button 1 (type 5K) which actuates the spare CO_2 bottles.
6. Two electromagnetic air valves 8 to close the ventilation shutters of the undercowl space.
7. Squibs 6 in the discharge bonnets of the CO_2 bottles
8. Switch 5 (type 2B-45).

The system functions as follows:

Closure of 2B-45 switch 5 mounted on the fuel control panel prepares the system for operation. The switch closed,

voltage is supplied from the A3C-15 circuit breaker to all the overheat warning units, the buttons of the button lamps and the fire cocks. The system can be actuated either automatically or manually.

Automatic engagement is effected by overheat warning units 7 (type TM). Due to the fact that the aircraft is structurally divided into six fire-isolated sections, all the overheat warning units (fire warning units) are arranged in six groups. Each fire-isolated section is provided with 4 to 8 overheat warning units.

The overheat warning unit, type TM, (Fig.20) is bimetallic diaphragm 1; as soon as the ambient temperature rises to 140 - 170°C the diaphragm cambers to interconnect central contact 3 and side contact 2 of the unit.

Note: The system is wired so that the closing of switch 2B-45 applies voltage to the central contact of the overheat warning unit.

The central and side contacts of each warning unit installed in the same section are connected in parallel; therefore, operation of any overheat warning unit of a particular section is sufficient for actuation of all the fire cocks. Through the contacts of the actuated warning unit voltage is supplied to the fire warning light (the button lamp, see Fig.21) and to the electro-magnet of the fire cock.

Mounted in the top part of the button lamp is lamp holder 2 for the warning light provided with a red light filter, and the bottom part of the assembly is button 3 (type 204K). The lamp holder can be moved along the assembly axis, so when pressure is exerted to its filter, it is depressed to engage the button. All the button lamps are mounted on the fuel control panel.

Each fire cock 3 (See Fig.19) consists of a valve, electromagnet with the engaging and holding windings and of two microswitches.

Main Technical Date of Fire Cock

Voltage ..... 27 V ±10%
Current consumed:
at engagement ..... not over 6 to 7 A
when engaged ..... 0.3 to 0.4 A
Opening time ..... not longer than 1s

As the electromagnet is energized, current is applied first to engaging winding B which ensures reliable valve opening to connect the line running from the CO_2 bottles to the corresponding section of the aircraft. When the valve is opened fully, the cock microswitches operate to do the following:

- opening of the engaging winding supply circuit as a result of which the valve remains open due to the action of holding winding "y";
- blocking of the holding winding supply circuit as a result of which the valve remains open even in case the contacts of the actuated overheat warning unit get accidentally open;
- current supply to РП-2 relay 2 which, in its turn, will apply current to squib 6 in the discharge bonnets of the CO_2 bottles. From these bottles the carbon dioxide will pass via the open valve of the actuated fire cock into the corresponding aircraft section to extinguish the fire.

The second pair of CO_2 bottles is actuated manually with the aid of button 1 on the fuel control panel if by the moment it is depressed the РП-2 relay (Ref.No.2, Fig.19) is closed, i.e. when at least one fire cock is open.

The relay, type РП-2, is also mounted on the fuel control panel.

Note: Due to the fact that when engaged the fire cock blocks its own supply circuit with the microswitches, the fire cock can be disengaged only by turning 2B-45 switch 2 off. Placing the switch

off will repeatedly prepare the system for operation if it has been used once in flight, with exhaustion of only one pair of CO_2 bottles.

If in case of fire the system fails to operate automatically, it can be hand-operated. For hand control it is necessary to press button lamp 4 of the corresponding aircraft section. The contacts of the button are connected in parallel with the contacts of the overheat warning units, due to which the system operates in an exactly the same manner as when actuated automatically.

When the engine nacelle overheat warning units are actuated or when the button lamp connected to the aircraft section is depressed, energized in addition to the fire cock are:

- electromagnetic air valve 8 which supplies compressed air to close the ventilation shutters of the undercowl space;
- the engine electric equipment system; due to this, with the throttle control lever in the STOP (СТОП) position, the compressor air blow-off band is closed.

2. CIRCUITRY OF FUEL SHUT-OFF AND CROSS-FEED VALVES AND OF INERT GAS SYSTEM

The electric system ensures opening and closing of the fuel shut-off valves installed in the main fuel supply line delivering fuel to all the tank groups of the respective engine, and of the cross-feed valve which interconnects the main fuel supply lines of both engines; the electric system also provides for signalization of the open and closed positions of the fuel shut-off valves and opening of the inert gas bottles.

The electric circuit (Fig.22) comprises:

1. Electric actuators 5 and 14, type МЗК-2, of the fuel shut-off and cross-feed valves.
2. Change-over switches 1 and 3, type ПП-45, for valve control.

3. Signal lights 2 (type СЦШ-51) which indicate the open position of the fuel shut-off valves.

4. Squibs 15 in the inert gas bottle discharge bonnets.

5. Switch 4 (type B-45) which engages the squibs.

The fuel shut-off and cross-feed valves are closed or opened by corresponding settings of their change-over switches mounted on the fuel control panel.

With one of the switches closed, voltage is applied through an A3C-5 circuit breaker to one of the windings of the D.C. series-wound reversible electric motor of the M3K-2 actuator of the corresponding valve. For the general view of the M3K-2 actuator see Fig.23.

The electric motor drives the output shaft through planetary reduction unit elements 8, 10 and 12 (See Fig.22).

Main Technical Data of Actuator, Type M3K-2

Operating voltage range ..... 23.4 to 28.6 V
Rated thrust ..... 2.5 kgm
Current required ..... not over 3.3 A
Output shaft rotation angle ..... not smaller than 95°

The fuel shut-off valve open position signal lights are mounted on the fuel control panel; unlike the other signal lights of the panel they are mounted so that it is possible to effect their dimmer control without opening the face boar of the panel. This is done so because the above lights are used to indicate to the pilots only before the take-off that the valves are open.

Closing switch 4 provided on the fuel control panel simultaneously discharges all the inert gas bottles; the bottles are discharged when the aircraft enters an anti-aircraft fire-dangerous zone.

3. FLAP CONTROL

The flaps are extended and retracted by means of an electric system; the flap control is effected remotely, from the stations of the pilot and co-pilot with the aid of an electric actuator, type МП3-3М (Fig.24).

The electric actuator, type МП3-3М, consists of two identical series-wound reversible motors (top motor No.2 and bottom motor No.1) which both drive one reduction unit rotating the driving shaft of the flap control mechanism.

The planetary-type reduction unit of the actuator is provided with a differential and makes it possible to retract or extend the flaps with only one electric motor of the actuator in case of failure of the other.

For the current required to drive the actuator motors, as well as for the flap retraction and extension time see the Table below.

Actuator duty	Maximum current required, A		Maximum operation time, sec.	
	with both motors	with one motor	with both motors	with one motor
Extension	155	80	25	50
Retraction	160	85	25	50

The actuator, type МП3-3М, is installed in the bomb bay above the port side wing. The electric motors are engaged by contactors, type К-250 (Fig.25), which are mounted in the flap control junction box (Fig.26); top electric motor No.2 is connected to the bus bar supplied from the fuse, type МП-150, installed in the left dual supply circuit junction box. Bottom electric motor No.1 is fed through the МП-150 fuse mounted in the right junction box of the dual supply circuit (the box is installed in the bomb bay at frame No.42).

The electric motors of the МП3-3М actuator are engaged by the limit switches, type МКП-11, installed on the flap

control driving shaft, as soon as the flaps reach one of their extreme positions.

The MKB-11 limit switch mechanism is designed for closing the electric circuits after the mechanism output shaft turns a certain predetermined number of revolutions. The operating moment of each limit switch is adjusted according to the existing operation instructions authorized for the aircraft, model TU-16. The flaps can be controlled both by the pilot and the co-pilot with the aid of the change-over switches installed on the engine control panels.

In order to prevent such a situation when one of the pilots engages the flaps for extension while the other initiates their retraction (which may result in failure of the MP3-3M actuator), the pilot's change-over switch is blocked from the co-pilot's switch by means of a PP-2 relay in such a way that the co-pilot can operate the flaps only when the pilot's change-over switch is in the neutral position (See the Diagram, Fig.25).

The relay, type PP-2, is mounted on the left-hand engine control panel. The change-over switch at the co-pilot's station is of a push type; when released, it returns to the neutral position.

Each of the MP3-3M actuator electric motors has its self-contained control circuit protected by an A3C-5 circuit breaker. The circuit breakers are installed on the circuit breaker panel of the pilot.

The power circuits of the MP3-3M actuators and of their control systems are fed from the dual supply bus bars.

With change-over switch 13 (type 3PP-45) placed for flap extension (В ПОЛЕТ) position, power is applied (See the Diagram, Fig.25) through the closed contacts of MKB-11 mechanism limit switches 10 to the field windings of K-25C contactors 8 and 14. The contactors operate to engage electric motors Nos 1 and 2 of the MP3-3M actuator for flap extension.

As soon as the change-over switch is placed for flap extension or retraction, voltage is applied to the field winding of blocking relay 12 (type PP-2) which operates to break the flap control circuit operated from push-type change-over switch 11, type 2PP-20, installed at the co-pilot's station.

Therefore, with change-over switch 13 closed, it is impossible to effect flap control from change-over switch 11.

After the flaps are extended through the required angle (the position of the flaps is indicated by UZP-47 flap position indicators 16), switch 13 must be set to the neutral (OFF position). The field windings of contactors 8 and 14 will be de-energized, and the contactors will disconnect the two electric motors of the MP3-3M actuators.

With the flaps being in their extreme positions, the electric motors of the actuator are disconnected by MKB-11 limit switches 10 which break the field circuits of contactors 8 and 14 or 9 and 15 when the flaps are either in the full DOWN or in the full UP positions irrespective of the positions of change-over switches 13 and 11. The flaps are retracted in a similar way, but K-25C contactors 9 and 15 are actuated to engage the electric motors for flap retraction.

The flaps can be controlled from change-over switch 11 only with switch 13 being in the neutral position; the control procedure is identical to that with use of change-over switch 13.

Main Technical Data of Actuator, Type MP3-3M

Nos	Description	Two-motor operation	One-motor operation
1	2	3	4
1	Rated voltage	27 V	27 V
2	Operating voltage range	24.3 to 29.7 V	24.3 to 29.7 V
3	Rated thrust output	10 kg-m	10 kg-m
4	Maximum thrust output	15 kg-m	15 kg-m

1	2	3	4
5	Rated current, maximum	190 A	100 A
6	Maximum current	250 A	125 A
7	Mechanism output shaft speed at rated voltage and rated thrust conditions, min.	240 r.p.m.	120 r.p.m.
8	Mode of operation of actuator	intermittent:	

(a) in two-motor operation: the output shaft rotates counter-clockwise (at rated voltage and rated thrust) during 30 seconds, then follows a 5-sec. interval, and the shaft starts into clockwise rotation (under the same operating conditions) which lasts 30 seconds, with a new 5-sec. pause to follow. The number of such operation cycles is 5, then follows complete cooling;

(b) in one-motor operation: the output shaft rotates counter-clockwise (under rated voltage and rated thrust conditions) during 60 seconds, then follows a 10-sec. break, and the shaft starts into clockwise rotation (under the same operating conditions) which lasts for 60 seconds, with a new 10-sec. pause. The number of such operating cycles is 2, after which follows complete cooling.

9 Weight of actuator - not over 43 kg.

Note: The direction of the output shaft rotation is determined from the side of the larger diameter of the angular transmission system. Counter-clockwise rotation of the shaft corresponds to flap extension while clockwise rotation corresponds to flap retraction.

Flap Position Indicator, Type УЗП-47

At take-off the landing flaps should be 19° to 23° DOWN. At landing the flaps are let down through 35° ±1°. For control over the flap extension angle the aircraft is provided with a flap position indicator, type УЗП-47. The instrument set consists of one transmitter and two indicators, type УЗП-47. The transmitter is installed on the МКП-2 limit switch mechanism mounted on the flap transmission shaft. The indicators are connected in parallel and installed on the instrument boards of the pilots. The instrument is fed from the dual power supply bus bar (See Fig.25) and is provided with a circuit breaker, type АЗС-2, which is installed on the pilot's circuit breaker control panel.

The operation of the flap position indicator is based on the employment of a ring rheostat connected to a three-phase permanent-magnet-type ratiometer.

Main Technical Data of УЗП-47 Instrument

Voltage ..... 27 ±2.7 V
Operating ambient air temperature range .. from plus 50°C to minus 60°C
Remote transmission error ..... ±2°
Power consumed by full set ..... not in excess of 5 W
Current required by transmitter ..... not over 0.1 A

4. TRIM TAB CONTROL

The trim tabs of the aircraft are controlled electrically. All the trim tab actuators are fed from the normal power supply bus bar of the pilot's circuit breaker control panel and are protected with АЗС-5 circuit breakers.

Aileron Trim Tab Control

The aileron trim tabs are controlled by two actuators, type МП-100ОА-60, mounted on the left and right ailerons.

The actuator, type МП-100А-60 (Fig.27), is designed for actuation units and mechanisms performing motions of translation, the rated thrust being up to 100 kg.

The actuator construction employs a two-pole D.C. reversible electric motor, type Д-4ТН, with series excitation and an electromagnetic brake clutch.

The stroke length of the actuator stem screw equals 60 mm. Mounted inside the actuator (Fig.28) are: two limit switches 7, one blocking contact 6 to synchronize the neutral position of the actuating screw; the blocking contact of the left aileron trim tab actuator is connected with white signal light 9, and the blocking contact of the right aileron trim tab actuator is connected with white signal light 18. Blocking contact 6 operates (to close the contacts) only when the ailerons are neutral.

The electric actuators of the aileron trim tabs are controlled with the aid of push-type 2ПН-20 change-over switches 12 mounted on the trim tab control stations of the pilot (Fig.29) and co-pilot. Closure of one of change-over switches 12 engages both МП-100А-60 actuators in operation; the actuators function as follows: when one actuator deflects its trim tab down, the other deflects its respective trim tab upward.

The neutral position of the aileron trim tabs is indicated by white light 18, type СЦШ-51, installed on the pilot's instrument panel (Fig.28).

Installed in the top section between frames Nos 9 and 10 for pre-flight neutral positioning of the aileron trim tabs is an aileron trim tab synchronization station (Fig.30). Mounted on the station is push-type change-over switch 11 (type ПН-45, see Fig.28) which is connected to the control circuit of the left aileron trim tab actuator and to the circuit of white СЦШ-51 signal light 9 which indicates the neutral position of the actuator.

The station is provided with a cover; when the cover is closed, КВ-6-1 blocking contact 10 disconnects light 9.

Rudder Trim Tab Control

The rudder trim tab is controlled by means of an electric actuator, type МП-100А-36, which is installed in the rudder and is connected to the trim tab through a linkage system. The stroke length of the stem screw of the МП-100А-36 actuator equals 36 mm.

Mounted inside the actuator are two limit switches which restrict the stroke length of the screw, and one blocking contact to synchronize the neutral position of the actuating screw; the contact is connected with a signal light. The internal system of the МП-100А-36 actuator is similar to that of the actuator, type МП-100А-60 (presented in Fig.28).

The rudder trim tab is controlled by means of push-type change-over switches 13 (type ПН-45) which are installed on the trim tab control stations of the pilot and co-pilot and are connected in parallel. The pilot's instrument panel carries white СЦШ-51 light 17 which indicates the neutral position of the trim tab.

Basic Technical Data of МП-100А Actuators

Rated voltage	27 V
Operating voltage range	24.3 to 29.7 V
Rated current required	1.35 A
Maximum current	1.4 A
Rated stem load	100 kg
Maximum stem load	150 kg

Elevator Trim Tab Control

The elevator trim tabs are controlled by means of an electric actuator, type УТ-11 (Fig.31), mounted in the non-pressurized section of the fuselage at frame No.69. The УТ-11 actuator revolves the cable drum, thus changing the position of the elevator trim tabs through a cable system. The travel of the УТ-11 actuator is restricted by two ВК-2-141В limit switches 16 which are linked to the trim tab control cables.

The actuator is controlled from push-type ПН-45М change over switches 15 mounted on the spokes of the pilots' control wheels and are connected in parallel.

The actuator, type УТ-11, is provided with electromagnetic clutch 24 with a cable drum; it is engaged only when the trim tabs are controlled electrically. In the interim the cable drum is disengaged from the УТ-11 actuator and can be driven by the cables running from elevator trim tab control handwheels; these provisions ensure reliable control of the elevator trim tabs.

Mounted on the side wall of the fuel control board for emergency disconnection of the trim tab electric control system is switch 14 (type В-45) which makes it possible to disconnect the УТ-11 actuator power supply in case of feeder failure.

The elevator trim tabs have mechanical position indicators mounted on the manual control handwheels.

Main Technical Data of УТ-11 Actuator

Rated voltage	26 V
Operating voltage range	23.4 to 28.6 V
Rated shaft thrust (output thrust)	180 kg-cm
Maximum shaft thrust	260 kg-cm
Output shaft speed at nominal voltage	7 r.p.m. ±10%
Current required at rated thrust	not over 2.8 A
Current required at maximum thrust	not over 3.3 A
Mode of operation	intermittent

5. LANDING GEAR WARNING AND TAIL SKID CONTROL

The landing gear is extended and retracted with the aid of hydraulic units and therefore they are not to be described in the present Section.

The landing gear position warning system uses СЦШ-51 signal lights (red lights for the L.G. retracted position and green lights for the L.G. extended position) mounted on the middle electric control board of the pilots: three green-screened and three red-screened lights.

Employed as L.G. position transmitters are limit switches, type ВК-44, mounted in the wells of the corresponding L.G. legs.

The signal lights (Fig.32) are fed from the dual supply bus bar through an А3С-2 circuit breaker installed on the pilot's circuit-breaker control panel.

Tail Skid Control

The retraction and extension of the tail skid are controlled by an electric actuator, type МП-250.

The МП-250 actuator is designed for control of units and mechanisms performing motions of translation, the stem (operating rod) load not exceeding 250 kg.

Used in the actuator is a two-pole D.C. series-excited reversible motor, type Д-25Т, with electromagnetic brake clutch which serves to reduce the inertia travel of the actuator stem.

For the reversing action the motor is provided with two self-contained field windings located at the opposite poles.

The МП-250 actuator is controlled automatically depending on the position of the nosewheel leg. As the nosewheel leg is being extended (See the Diagram, Fig.32), ВК-44 limit switch 8 mounted on the nosewheel leg shock strut operates to engage МП-250 actuator 9 for tail skid extension.

The tail skid retraction is carried out after complete retraction of the nosewheel leg, i.e. when limit switch 8 is re-set to engage the МП-250 actuator for L.G. nosewheel leg retraction. With the tail skid being in the extreme position, the МП-250 actuator is disengaged by means of limit switches.

The system ensures almost simultaneous extension of the L.G. nosewheel leg and tail skid. The retraction is performed in succession, i.e. the МП-250 actuator is engaged for tail skid retraction only after the landing gear nosewheel leg is fully retracted.

Retracted position of the tail skid is indicated by the lighting of two green СЛШ-51 lights 7 provided on the electric control boards at the stations of the tail cannon operator and radio-and-cannon operator. When these lights are on, this means clearance for operation of the lower cannon mount.

The electric actuator, type МП-250, is fed from the normal power supply bus bar through a delayed-action fuse, type ИП-5, located in the dual supply circuit junction box mounted on the port side at frame No.17.

Main Technical Data of МП-250 Actuator

Rated voltage	26 V
Operating voltage range	23.4 to 28.6 V
Rated load	250 kg
Maximum load	375 kg
Stem stroke length	180 ±1 mm
Stem speed	6 mm per second
Current required:	
at nominal load	not over 3 A
at maximum load	not over 3.5 A
Weight of actuator	not in excess of 4.2 kg
Mode of operation	intermittent: continuous extension and retraction operation followed by a 1-min. break. The number of such cycles is 5. The interval after 5 cycles - at least 1 hour

6. HYDRAULIC SYSTEM CONTROL

The hydraulic system electric control is automatic. The pressure selector, type ПДИЭ-150, is designed for control and indication of the pressure of the hydraulic system mixture. The hydraulic mixture is delivered by an electrically operated hydraulic pump, type НШ-29 (Fig.33), which is a hydraulic unit combining a gear pump and a drive, a D.C. electric motor, type Д-4500, with compound excitation.

If the pressure in the main hydraulic system drops below the tolerated level, the НШ-29 hydraulic pump is automatically engaged for mixture delivery by means of the ПДИЭ-150 pressure selector.

The electrically operated hydraulic pump (Fig.34) is set in operation by К-400Д contactor 6 the field winding of which can be closed either through РП-2 intermediate relay 5 connected to ПДИЭ-150 pressure selector 1, or through push-type switch 7 (type ВН-45М). Thus in case the automatic system fails the hydraulic pump can be engaged by pressing HYDRAULIC SYSTEM BOOST PUMPING (ПОДКАЧКА ГИДРОСИСТЕМЫ) push-type switch ВН-45М mounted on the middle control panel of the pilots.

In case of zero or lower-than-rated pressure in the main hydraulic system contacts В and Г (See the Diagram, Fig.34) will be closed, and red СЛШ-51 signal light on the middle electric control board will flash up. Contacts А and Б out into the field circuit of РП-2 auxiliary relay 5 will be open.

As soon as the pressure in the hydraulic system reaches 30 kg/cm^2 which happens by engaging the hydraulic pump with the aid of ВН-45М push-type switch 7, contacts А and Б close the field circuit of РП-2 relay 5 which operates

to close the field circuit of К-400Д contactor 6 which engages НШ-29 hydraulic pump 8. The pressure in the system begins to increase (as soon as the hydraulic system pressure reaches 30 kg/cm^2, ВН-45М switch 7 gets open, and further control of the hydraulic pump is effected through the pressure selector, type ПДМЭ-150).

When the pressure rises to 100 kg/cm^2, contacts В and Г open and signal light 3 goes out to indicate the minimum working pressure in the hydraulic system.

When a pressure of 120 kg/cm^2 is reached, contacts Д and Е open, the circuit of contacts А and Б remaining closed. The hydraulic pump continues its operation.

As soon as a pressure of 150 kg/cm^2 is built up, contacts Е and К close to apply voltage to coil Л of the relay. The relay armature will break the circuit of contacts А and Б of РП-2 auxiliary relay 5 and К-400Д contactor 6 will operate to interrupt the hydraulic pump operation.

Pressure drop below 150 kg/cm^2 results in opening of contacts Е and К, but the armature will be still held in the given position due to the armature spring. As soon as the pressure drops to 120 kg/cm^2, contacts Д and Е will close to apply voltage to coil М; the armature will close the circuit of contacts А and Б, and the hydraulic pump will be engaged again. If the pressure in the hydraulic system drops to 100 kg/cm^2, contacts В and Г will close and the signal light will flash up to indicate that the pressure has reached its minimum value. As soon as the pressure drops to 30 kg/cm^2, contacts А and Б will be opened, and the hydraulic pump will be disengaged.

Pressure drop in the emergency hydraulic system is indicated by СПМ-130 pressure drop warning unit 2 and red-screened СЛЦ-51 signal light 4 which is also mounted on the middle electric control board of the pilots.

The operating principle of the warning unit, type СПМ-130, is similar to that of the pressure selector, type ПДМЭ-150.

When the pressure in the warning unit connector is 130 kg/cm^2, the contact strip moves away from the fixed contact to open the electric light signalization circuit.

At a pressure drop below 130 kg/cm^2, the contacts will close and the signal light will flash up to indicate that the pressure in the emergency hydraulic system has reached its minimum value. The pressure selector, type ПДМЭ-150, and the pressure drop warning unit, type СПМ-130, are located on the hydraulic control panel in the front non-pressurized section of the fuselage on frame No.15.

Main Technical Data of ПДМЭ-150 and СПМ-130 Instruments

Rated voltage ..... 27 V ±10%

Accuracy of operation of contacts:

under normal temperature and relative humidity conditions ..... within plus 5 to minus 2 kg/cm^2

at temperature of plus to minus 60°C ..... within plus 6 to minus 3 kg/cm^2

The hydraulic pump, type НШ-29, is fed from the normal power supply bus bar through a delayed-action fuse, type МП-250. The feed of the control and signalling circuits is accomplished from the pilot's circuit breaker control panel through АЗС-2 circuit breakers; the hydraulic pump control circuit is fed from the normal power supply bus bar, while the signalling circuit is supplied from the dual power supply bus bar (See the Diagram, Fig.34).

The units engaging the НШ-29 electrically operated hydraulic pump (the К-400Д contactor, the РП-2 auxiliary relay and the МП-250 delayed-action fuse) are located in the hydraulic system control panel junction box (Fig.35) installed in the non-pressurized section of the fuselage, in the area of frame No.15.

Main Technical Data of Electrically Operated Hydraulic Pump, Type НЕ-29

Working pressure of delivery	150 kg/cm^2
Maximum pressure of delivery	180 kg/cm^2
Rated voltage	26 V
Operating voltage	23 to 29 V
Current required:	
at working pressure of 150 kg/cm^2	not over 180 A
at maximum pressure of 180 kg/cm^2	not over 260 A
probable 2-sec. current peaks	not in excess of 300 A
Operating ambient temperature range	±55°C
Maximum performance altitude	up to 12,000 m.

7. DRAG CHUTE CONTROL

To reduce the landing run, the aircraft is provided wi a drag (tail) parachute. The chute release buttons are moun on the trim tab control stations (See Fig.29). The right an left instrument panels of the pilots carry two green lights, type СЦШ-51, which indicate the drag chute release. Mounte beside the lights are the drag chute dropping buttons.

As soon as one of the drag chute release buttons is pressed (the release buttons, as well as the chute dropping buttons are connected together in parallel), the squibs, type ШІ-3, in the removal guns go off to open the doors of the chute container, and the drag chute is let out with the aid of the pulling (rip) parachute.

Closed at the same time are the contacts of the limit switch, type ВК-2-141В, coupled with the linkage system of the drag chute release (the limit switch, type ВК-2-141В, is installed in the fuselage tail section in the area of frame No.67). As soon as the contacts of the limit switch a closed, the green signal lights, type СЦШ-51, flash up to indicate that the drag chute is released.

The chute is dropped by pressing one of the buttons which loses the circuit of the squibs in the remover guns of the rag parachute dropping system.

The drag chute control system is fed from the normal ower supply bus bar controlled from the pilot's circuit reaker panel through an АЗС-5 circuit breaker.

8. DE-ICERS AND HEATERS

De-icer

The leading edge sections of the fin and stabilizer are rovided with electrically operated thermal de-icers. Each le-icer consists of sections, assemblies and heating elements.

The stabilizer de-icer is divided into two sections:

(a) the inner section which heats the root areas of the eft and right L.E. sections of the stabilizer;

(b) the outer section which heats the tip areas of the tabilizer L.E. sections.

The fin de-icer has only one section which consists of ne assembly. The outer and inner sections of the stabilizers onsist of two assemblies each; the assemblies are installed n the left and right panels of the stabilizer.

The left- and right-panel assemblies of each stabilizer le-icer section are connected together in parallel (Fig.36). Each assembly incorporates several heating elements which are eries-connected between each other.

The heating elements are mounted between the skin and the inner plating of the leading edge sections.

Each assembly of the de-icer sections is provided with a bimetallic thermal switch, type 777-В, which breaks the minus power supply circuit of the К-600Д contactor disengaging the de-icer section as soon as a temperature of 70 +10°C is reached.

The de-icer sections operate intermittently: each cycle consists of 40 seconds during which the sections are energized and 80 seconds during which they are de-energized. The

cycle is governed by an electric actuator, type МКА-3А, (Fig.37) which actuates the de-icer sections one after another through contactors, type К-600Д.

The actuator, type МКА-3А, consists of the following three major parts: a shunt-wound two-pole electric motor, a reduction unit and a contact assembly.

The actuator is mounted in the non-pressurized tail section of the fuselage, port side, at frame No.63. The actuator is fed from the normal power supply bus bar through an АЗС-3 circuit breaker mounted on the co-pilot's circuit breaker control panel. The de-icers are controlled from the upper (overhead) electric control board of the pilots by means of a В-45 switch.

The power contactors, type К-600Д, and the fuses, type ТП, rated for 600 A which are part of the power circuit of the de-icer sections are housed in the tail unit de-icer junction box (Fig.38) which is installed in the tail non-pressurized section of the fuselage, port side, between frames Nos 63 and 63a.

The control over the operation of the de-icers is effected by a white light, type СЛЦ-51, which flashes up for 40 seconds after each 80-sec. interval to indicate that the outer de-icer section of the stabilizer is engaged. The light is mounted on the pilot's instrument panel.

When switch 7 (Fig.36) is closed, voltage is supplied to electric motor 3 of the МКА-3А actuator and, at the same time, through the closed contacts of contact assembly 5 - to the field winding of К-600Д contactor 9 which energizes inner section 11 of the stabilizer de-icer.

Motor 3 through reduction unit 4 turns contact assembly 5 and upon expiration of 40 seconds the closed contact of the МКА-3А actuator operates to break the field winding of the К-600Д contactor which disconnects inner section 11 of the stabilizer de-icer. Immediately upon disconnection of de-icer section 11, the second contact of contact assembly 5 operates to close the field winding circuit of К-600Д contactor 9 which engages outer section 1 of the stabilizer de-icer. The engagement of section 1 is accompanied by flashing-up of white signal light 8 which will go on burning as long as outer section 1 is in operation and will go out as soon as the outer de-icer section is disengaged after a 40-sec. operation period. Disengagement of section 1 results in actuation of the third contact of contact assembly 5; this contact will close the field circuit of the К-600Д contactor which engages section 10 of the fin de-icer.

Upon expiration of 40 seconds contact assembly 5 will disengage section 10, and the operating cycle of the МКА-3А actuator will be repeated. When switch 7 is opened, the МКА-3А actuator stops at any position of the contact assembly, i.e. the de-icers are engaged not necessarily beginning with the stabilizer inner de-icer section, but the sequence of the section-by-section engagement is strictly maintained by the actuator.

The section engagement order is presented in the Table below:

Nos	Description	Engagement sequence	Current required, A	Protection	Supply circuit relay
1	Inner section of stabilizer de-icer	I	450	ТП-600	К-600Д
2	Outer section of stabilizer de-icer	II	494	ТП-600	К-600Д
3	Fin de-icer	III	480	ТП-600	К-600Д

Main Technical Data of МКА-3А Actuator

Rated voltage ..... 27 V
Operating voltage range ..... 27 V ±10%

Rated current required by actuator motor ... not over 0.8 A
Rated current for switch contact opening ... 5 A (inductive load)
Mode of operation ..... continuous

The ground check of the de-icers is carried out by connecting the aircraft electric mains to a ground D.C. generator through the ground power supply plug connector.

An ammeter rated for 500 A is cut into the power supply circuit. The voltage is measured by the aircraft voltmeter. The heating degree is tried by hand or with the aid of a special instrument which consists of a thermocouple mounted on a telescopic stem with wires leading to the temperature indicator carried inside the stem. The cycle peri ds are checked with the aid of a stopwatch.

When checking the heating degree by means of the special thermocouple instrument, the indications will be considered normal if the surface temperature at any point of the given section of the de-icer leading edge section (boot) is about 30 to 50°C higher than the ambient air temperature (in the course of one cycle of the de-icer operation).

CAUTION: NEVER operate the de-icers for longer than 3 minutes on the ground.

The de-icer of the aircraft tail unit is engaged in the flight before the aircraft enters the ice-dangerous zone. The de-icer is engaged only if the de-icer boots of the tail unit are absolutely free of ice.

IMPORTANT: During a flight check of the tail unit de-icer, under icing-free conditions, the de-icer may be engaged for not longer than 5 minutes. In this case the operation of the de-icers is checked by the signal light and by the current consumed (with reference to the generator ammeters).

Electric Heaters

(a) Electrically Heated Glass Panels

To prevent frosting, the front glass panels of the two pilots and of the navigator are equipped with electric heating arrangements called the defrosters.

Each glass panel is an assembly of two hardened silicate glass panels with a heater element attached between them (Fig.39).

The glass panel heating degree is controlled by an automatic defroster control unit, type ACC-81N.

Thermister 2 (Fig.39) of each heated glass panel is cut into an electrical bridge circuit. The two other arms of the bridge are formed up by coils I and II of PN-4 polarized differential relay 1. Coils I and II have equal numbers of turns and are opposite-connected between each other. The fourth arm of the bridge is control rheostat (trimmer) 3. The PN-4 relay and the trimmer are located directly in the ACC-81N automatic defroster control unit.

If the glass panel temperature is too low, the thermister resistance will be large, and the currents in windings I and II of the PN-4 relay will be distributed in such a manner that the relay will operate to supply voltage to the heater elements of the glass panels.

The temperature will be rising while the thermister resistance will undergo gradual decrease, and at a temperature of 20 ±2°C for which the automatic defroster control unit is adjusted the thermister resistance change will be so great that due to re-distribution of currents in the bridge circuit the PN-4 relay will open its contacts to disconnect the defroster heating elements.

The automatic defroster control unit, type ACC-81A, has three independent channels, each channel ensuring automatic control of the defroster arrangement of its respective glass panel. Each channel comprises a bridge circuit with polarized

differential relay 1, type РП-4, and relay 15, type РЭ3-45, which relieves the load from the circuit of the polarized relay and is no part of the bridge circuit.

The trimmer (control rheostat) is used for adjusting the АОС-81М control unit for a certain glass panel temperatu to be maintained (20 $\pm 2^{\circ}$C). Connected in parallel with the contacts of the РП-4 relay is a spark-quench which consists of a resistor and a capacitor.

With В-45 switches 5, 6 and 7 of the pilots' and navigator's defrosters closed and with the resistance of thermisters 2 changing due to glass panel temperature change the bridge circuits of the automatic unit become unbalanced. Thus, for instance, if the thermister resistance increases due to decreased glass panel temperature, РП-4 relay 1 of each channel operates to apply voltage to the coils of РЭ3-45 relay 15 which in their turn will connect power supply to the field windings of contactors 8 and 9 connecting the defrosters of the pilots and navigator.

Automatic engagement of each defroster is effected by РП-4 polarized differential relay 1 which, as soon as the temperature in the point indicated in Fig.39 reaches 20 $\pm 2^{\circ}$C, breaks the field circuit of its РЭ3-45 relay. The РЭ3-45 relay operates to de-energize the field winding of contactor 8 or 9 which engages the defroster of the respecti glass panel.

Provision of three channels in the АОС-81М automatic defroster control unit ensures independent control of each separate glass panel defroster.

The АОС-81М control unit is installed at the starboard side, in the area of frame No.5; the defrosters at the two pilots are controlled by means of two В-45 switches mounted on the overhead electric control board of the pilots (Fig.40).

The navigator's defroster is engaged with the aid of a В-45 switch located on the overhead (upper) electric contr board of the navigator. The pilots' defroster current is supplied through two relays, type К-50Д, and that for the

navigator's defroster is fed through a relay, type К-100Д. The power supply circuits are protected with three fuses, type НП, two of which are rated for 75 A, and the third - for 100 A.

The fuses and the relays are located in the defroster control junction box (Fig.41) which is mounted on the star-board side of the front pressurized cabin at frame No.6.

The control circuits are fed from the normal power supply bus bars through three АЗС-2 circuit breakers installed on the circuit-breaker control panels of the pilot and co-pilot and on the left-hand circuit breaker control panel of the navigator.

The adjustment of the АОС-81М unit and check-up of the entire system should be carried out in accordance with exist-ing operating instructions of the aircraft, model ТУ-16.

(b) Cabin Electric Heaters

To prevent dimming of the glass panels, as well as to provide additional heating of the cabins, each pressurized cabin is fitted out with one electric heater, Index 107, (Fig.42). In the front cabin the electric heater is installed at the starboard side in the area of frame No.5, and in the rear pressurized cabin the heater is mounted on the port side in the area of frame No.73.

The electric heater, Index 107, is a heating appliance with three electric heating elements and a fan. Each electric heater is controlled with the aid of three switches, type В-45; switch 9 (Fig.43) is used to control the heater fan, while the other two (10 and 11) are used to operate the sections of the heating elements. The first section consists of two heating elements 6, and the second section has one element.

The design of the heater makes it impossible to engage the heater sections unless the fan is on.

To prevent overheating that may be caused by decreasing air density with altitude, the heater is provided with change-over switch 5 (Index 131A) installed in the heater; the switch disconnects one heating element of the heater (the second section) at an altitude of 7000 m.

Mounted inside the heater is thermal switch 4 (Index 129) which disconnects all the heating elements of the heater in case of their overheating. Due to the operation of РП-2 blocking relay 2, the heater is not re-engaged automatically after it cools off; to re-engage the heater it is necessary to open all the three heater control switches and then to close them again one after another.

Closing the switches of the first and second sections of the heater results in operation of three К-50Д contactors 7 (See the Diagram, Fig.43) which are installed inside the heater. Each of these contactors connects or disconnects one heating element 6. The minus circuit of the field windings of all the three contactors can be broken by РП-2 blocking relay 2 which operates only after the automatic re-setting of bimetallic thermal switch 4 in case the heater is overheated. As the heater is being cooled down, the РП-2 relay remains energized as its field winding is fed through its own contact. The voltage supply to the field winding of blocking relay 2 can be interrupted only by disengaging fan 9.

The minus circuit of the field winding of the К-50Д contactor which connects the heating element of the second section is additionally broken by altitude change-over switch 5 (Index 131A) as soon as the altitude of 7000 m. is reached; this action disconnects the second section of the heater.

All the three heater control switches of the front pressurized cabin are located on the overhead electric control board of the pilots, and the control switches of the rear pressurized cabin heater are mounted on the radio operator's electric control board (See Figs 40 and 44).

Basic Technical Data of Heater, Index 107

D.C. voltage ..... 27 V ±10%
Total current of the circuit of three heaters at 27 V ..... not in excess of 135 A
Current of the fan motor circuit at 27 V ..... not in excess of 30 A
Air flow through heater on the ground, with air pressure head at heater outlet not less than 250 mm water gauge ..... not less than 230 kg/hr
Air temperature at heater inlet ... 20 ±10°C
Time required for heating element automatic disconnection after the motor is disconnected ..... not longer than 180 sec.
Fan motor power ..... not over 650 W
Motor speed ..... 5800 to 12,000 r.p.m.
Weight ..... not more than 12 kg.

Power is supplied to the heater sections, to the heater control circuits and to the fan motors from the normal power supply bus bars.

Used to protect the power circuits of the heaters are fuses, type МП-150; one of the fuses (protecting the front cabin heater) is located in the defroster control junction box mounted on the starboard side of the front pressurized cabin at frame No.6, and the other (protecting the rear cabin) is installed in the rear cabin junction box mounted on the port side at frame No.74.

Two АЗС-30 circuit-breakers of the control circuits and of the heater fans are located in the following places: one (for the front cabin) - on the co-pilot's circuit breaker control panel, and the other (for the rear cabin) is mounted on the circuit breaker control panel of the rear cabin.

To decrease radio interference, cut into the plus circuit of the fans of both heaters are КБМ-31 capacitors 8 (Fig.43).

(c) Electric Heating of Pitot Tubes, Type ТП-156

To prevent icing of the air intakes of the ТП-156 pitot tubes, they are provided with electric heating arrangements. The heaters are controlled from two switches, type B-45, mounted on the overhead electric control board of the pilots.

The aircraft carries three ТП-156 tubes: two on the port side between frames Nos 7 - 8 and at frame No.6, and the third - on the starboard side at frame No.6.

The left top pitot tube is used in conjunction with the instruments of the pilot and navigator and the velocity head warning units, type ССН-3. The heater is fed from the bus bar which supplies the instruments from the storage battery under de-energized mains conditions (the triple power supply bus bar through an АЗС-5 circuit breaker located on the co-pilot's circuit breaker control panel.

The left bottom pitot tube operates in conjunction with the instruments of the radar operator, as well as with the НИ-50Б air position indicator (dead reckoning instrument system) and the bomb-sight, type ОПБ-11р. The right pitot tube operates with the instruments of the co-pilot and radio-gunner. The heaters of these two tubes are fed from the dual power supply bus bar through an АЗС-10 circuit breaker mounted on the co-pilot's circuit breaker control panel.

The switch of the first heater and the master switch of the two other heaters are installed on the overhead electric control board of the pilots.

For the circuit diagram of the ТП-156 pitot tube heating system see Fig.45.

(d) Electric Heating of Autopilot

Used for heating the servo units, directional stabilizer and vertical gyro of the autopilot, type АП-5-2М, are special heating covers which are provided with electric heating elements. The heating elements are supplied from the aircraft

mains. To connect the heating system it is necessary to insert the plugs of the heating cover cables into the sockets located close to the above units of the autopilot.

To prevent overheating of the heated units, the heating covers are fitted out with thermostats (thermoregulators) which automatically disconnect the heating elements as soon as the critical heating temperature is reached.

The autopilot heating system sockets are located at the following points: the directional stabilizer socket - at frame No.1, the vertical flight gyro socket - at frame No.9 of the front pressurized cabin, and the sockets for the three servo units of the autopilot - in the non-pressurized section of the fuselage at frames Nos 33 and 68.

The sockets of the heater circuits of the aileron servo unit, directional stabilizer and vertical gyro are energized through an АЗС-10 circuit breaker installed on the pilot's circuit breaker control panel; the power is supplied through a switch, type B-45, mounted on the overhead electric control board of the pilots.

The sockets supplying the heater circuits of the elevator and rudder servo units are energized through, and controlled from, a circuit breaker, type АЗС-10, installed in a special box on the starboard side of the non-pressurized tail section of the fuselage, beside frame No.63a. All the sockets are energized from the normal power supply bus bars.

For the circuit diagram of the heating system see Fig.45.

9. ALTITUDE EQUIPMENT

For cabin temperature control the aircraft is provided with the following electric units:

1. Automatic cabin temperature controllers.
2. Low altitude ventilation actuators.

Automatic Cabin Temperature Controllers

Used in the function of automatic temperature controlle in the pressurized cabins of the aircraft are thermoregulato type TPTBK-45.

The thermoregulator set comprises a thermostat, type P (Fig.46) and an actuator, type MPT-1 (Fig.47).

The thermostat is a controlling element of the regulato while the actuator, type MPT-1, is an actuating element whic controls the bypass of the air supplied to the cabin through the turbine-operated cooler, type TKY, or, when the cooler passed by, through the cabin air supply regulator, type PKH.

Due to the isolation of the front and rear cabins from each other there are two identical temperature control syste one in each cabin.

Principle of Operation of TPTBK-45 Thermoregulator

The sensitive element of thermostat 10 (Fig.48) is bimetallic spiral 12. The spiral carries armature 13 which i case of cabin temperature fluctuations turns under the pressure of the spiral to close the corresponding contact and th to engage one of the windings of reversible electric motor M of MPT-1 actuator 15. The actuator turns its attached shutter of the by-pass valve by this or another angle directing the hot air flow either through the turbine-operated cooler (if the cabin temperature is higher than normal) or to by-pass the cooler (if the cabin temperature is lower than normal).

The regulator employs a negative feedback circuit which comprises electromagnet 11 and balance potentiometer 19. The feedback (balance) electromagnet is located in the thermostat and acts upon the armature of the bimetallic spiral. The electromagnet voltage is picked up from the balance potentiometer installed in the MPT-1 actuator. The potentiometer wip is rigidly attached to the output shaft (stem) of the actuator.

As to its direction the action of the feedback electromagnet upon the armature is opposite to the action of the bimetallic spiral upon the same armature. Therefore the MPT-1 actuator will go on turning the shutter until the voltage picked up from the balance potentiometer of the MPT-1 actuator is high enough to open the contacts of the bimetallic relay. The contacts can become open in an intermediate position of the by-pass valve shutter, i.e. when the hot air will be passing partially through the turbine-operated cooler and partially by-passing it through the PKH regulator directly into the cabin, thus ensuring the desired cabin temperature.

In the extreme positions of the shutter the electric actuator power supply circuit is interrupted by limit switches 18 which are mounted in the actuator proper.

The control of the electric actuator, type MPT-1, and, consequently, the regulation of the cabin air temperature, can be also effected manually, by means of П2КПН-45 change-over switches 14. The change-over switch has four positions: throw-over (fixed) position AUTOMAT (АВТОМАТ), push-button selected positions HOT (ГОРЯЧИЙ) and COLD (ХОЛОДНЫЙ), and neutral position OFF (ВЫКЛЮЧЕНО).

Main Technical Data of MPT-1 Actuator

Output shaft (stem) thrust ..... 120 to 200 kgcm
Rated voltage ..... 24 V
Operating voltage range ..... 20 to 28 V
Output shaft turn angle (less inertia run-out) ..... $135^{\circ} \pm 3^{\circ}$
Current required at rated thrust and voltage ..... not over 1 A

The thermostat for the front pressurized cabin is located on frame No.9 (starboard), and the MPT-1 actuator - in the front non-pressurized section of the fuselage at frame No.22 (starboard). The manual control change-over switch is mounted

on the co-pilot's instrument panel. The A3C-2 circuit breaker protecting the electric circuit is mounted on the circuit-breaker control panel of the co-pilot.

The thermostat for the rear pressurized cabin is located at frame No.72 (port side), and the MPT-1 actuator - at frame No.63 of the non-pressurized tail section of the fuselage (starboard). The manual control change-over switch is installed on the electric control board of the radio-gunner. The A3C-2 circuit breaker to protect the electric circuit is mounted on the circuit breaker control panel of the rear cabin. Both circuit breakers are fed from the normal power supply bus bars.

Low-Altitude Ventilation

Provided on the aircraft for cabin ventilation at altitudes up to 2000 m. is a ventilation system with air delivery through free air intake scoops. The air intake scoop control in the rear cabin is manual, while employed for this purpose in the front cabin is an electric actuator, type M3K-2. This actuator is controlled by means of ПН-45М change-over switch 9 (See the Diagram, Fig.48) which is installed on the overhead electric control board of the pilots. Change-over switch 9 is of push-type and makes it possible to select the desired degree of the air scoop opening.

In the extreme positions the M3K-2 actuator is disconnected by means of limit switches 5 irrespective of the position of change-over switch 9. The actuator is fed from the normal power supply bus bar located on the pilot's circuit breaker control panel through an A3C-2 circuit breaker.

Fans

To improve the working conditions, provided at the stations of each member of the aircraft crew is a fan, type ДВ-3, with blades of soft rubber.

The fans of the pilot, co-pilot and navigator are fed through a common A3C-5 circuit breaker mounted on the circuit-breaker control panel of the pilot (See the Diagram, Fig.45).

Three switches 4, 5 and 6 (type B-45) of these fans are mounted on the engine control stations of the pilot and co-pilot and on the overhead electric control board of the navigator.

The fan of the radar operator is fed from an A3C-2 circuit breaker installed on the radar operator's circuit breaker control panel. The same circuit breaker does double duty as a switch. The fans of the gunner and of the radio-gunner are fed from an A3C-5 circuit breaker installed on the rear cabin circuit breaker control panel, and their switches 7 and 8 (type B-45) are mounted on the electric control boards of the gunner and radio-gunner.

Provided in the dome of the rear cabin for airing the units of radar sight ПРС-1 under ground operating conditions are two fans, type ДВ-3. Apart from these the port side of the fuselage non-pressurized section between frames Nos 60 and 61 mounts an additional fan, type ДВ-3, employed for the same purpose.

All the three fans are fed simultaneously with the fans of the gunner and radio-gunner through an A3C-5 circuit breaker installed on the circuit breaker control panel of the rear cabin. The three fans are controlled from common B-45 switch 9 mounted on the electric control board of the radio-gunner operator. The plus circuit of these fans is broken by BK-44 limit switch 10 (See the Diagram, Fig.45) which is connected to the linkage system of the tail skid. When the tail skid is extended, the limit switch closes the fan power supply circuit, and with the tail skid retracted it opens the circuit, i.e. after the take-off all the three fans are automatically disconnected.

To decrease the radio interference level, cut into the plus circuit of each fan is capacitor 16, type КДМ-31. All the ДВ-3 fans are fed from the normal power supply bus bars.

10. LIGHTING SYSTEM

Interior Lighting of Aircraft

The aircraft interior lighting system uses dome lights, ultra-violet illumination arrangements, directed-beam lights and extension lamps. Used for illumination of the КИ-12 compasses is a separate lighting system with special lamps.

Employed for general lighting are dome lights, type ПС-45 without a special lens; the dome lights have reflectors and single-contact lamp holders which adapt electric lamps, type СМ-25, rated for 28 V, 20 W. Altogether the aircraft carries thirteen dome lights, type ПС-45.

In addition to the general dome lights, type ПС-45, used for illumination of the landing gear wells, are small dome lights, type ПСМ-51 which are used by the aircraft crew of maintenance personnel during maintenance operations performed in the landing gear wells.

Unlike ПС-45 dome lights the dome lights, type ПСМ-51, are not glitter-proof since they are used by the crew only for short periods of time.

The major parts of a small dome light are: the shell, the transparent cover glass and the reflector; mounted in the reflector opening is a single-contact lamp holder for a СМ-24 electric lamp rated for 28 V, 20 W. Serving as the second-pole of the lamp of the ПСМ-51 dome light (the same as the ПС-45 dome light) is the dome shell.

For the locations of dome lights, types ПС-45 and ПСМ-51 as well as for the installation places of switches which control these dome lights, see Table 7 below.

Table 7

Location of Dome Lights, Types ПС-45 and ПСМ-51, and Their Switches on Aircraft

Nos	Type of dome light	Location of dome light	Type of switch	Location of switch	Remarks
1	2	3	4	5	6
1	ПС-45	On ceiling of front pressurized cabin, between frames Nos 4 and 5	В-45	On dome light mounting panel	For navigator
2	ПС-45	On ceiling of front pressurized cabin, at frame No.9	В-45	Do	For pilots
3	ПС-45	On ceiling of fuselage non-pressurized section, at frame No.14	В-45	On radar operator's electric control board	For hydraulic control panel illumination
4	ПС-45	Do, at frame No.20	В-45	Stbd, on ПО-4500 inverter shelf bracket	
5	ПС-45	Do, at frame No.34	В-45	On radar operator's electric control panel	For bomb bay lighting
6	ПС-45	Do, at frame No.38	В-45	Do	Do

1	2	3	4	5	6
7	ПС-45	On ceiling of fuselage non-pressurized section, at frame No.42	В-45	On radar operator's electric control panel	For bomb bay lighting
8	ПС-45	Do, at frame No.46	В-45	Do	Do
9	ПС-45	Do, at frame No.49	В-45	Do	Do
10	ПС-45	Do, at frame No.59	В-45	Stbd, at frame No.62	
11	ПС-45	On stbd side of non-pressurized fuselage section at frame No.66	В-45	Do	
12	ПС-45	On ceiling of rear pressurized cabin, at frame No.71	В-45	On electric control board of radar operator	For radio-gunner
13	ПС-45	Do, at frame No.74	В-45	On electric control board of radio-gunner	For gunner
14	ПСМ-51	In L.G. left leg well			
15	ПСМ-51	In L.G. right leg well			
16	ПСМ-51	In nosewheel leg well, stbd, at frame No.20	В-45	On electric control board of radar operator	
17	ПСМ-51	In nosewheel leg well, port side, at frame No.20			

Used for illumination of control stations and panels, as well as of darker places and aircraft instruments is a lighting system, type КЛСРК-45, provided with a rheostat, operating button and a set of bulbs, type СМ-30, rated for 28 V, 0.17 A.

The aircraft is fitted with ten cabin lamps altogether. Two lamps are installed at the navigator's station, three at the pilots' stations, two for the radar operator, two for the radio-gunner, and one at the gunner's station.

Cabin lamps of the КЛСРК-45 system are mounted on special hinged brackets (Fig.49).

Some hinged brackets, in addition to the cabin lamps, mount ultra-violet illumination arrangements.

The cabin light of the gunner has no hinged bracket and is mounted on the ceiling of the rear cabin.

In case of necessity the КЛСРК-45 fixtures can be removed from their hinged brackets or from their bases and used as extension lamps.

Altogether the aircraft is fitted with three extension lamps which are kept in bags attached to the back wall of the middle control station of the pilots, on the web of frame No.9 of the front pressurized cabin (starboard), and on the port side at frame No.73 of the rear pressurized cabin.

The aircraft is provided with 13 power sockets, type 47K. For the locations of these sockets see Table 8 below.

Table 8

Location of Power Sockets, Type 47K, for Extension Lamps, Type ПЛ-10-36

Nos	Location	Remarks
1	Navigator's right-hand console	
2	Middle console of pilots	

Used for ultra-violet illumination are low-pressure luminescent mercury lamps, type УФО-4А, rated for 4 W each. The ultra-violet illumination system, type АРУ.ОЛ-45, is operated in set with a rheostat, type РУФО-45, which engages the ultra-violet illumination lamps and controls the radiatic intensity of the lamps. The АРУ.ОЛ-45 system is fitted with a special two-wire cable contained in a copper braiding whici serves as a third conductor. The end of one of the two wires, when cleaned from its braiding, has white insulation and the end of the other wire has white insulation distinguished by a black thread. The wire having black-thread white insulatio is not used in the lamp circuit and is insulated from it. Th braiding enveloping the wires of the fixture is connected to the airframe either directly or through a piece of aviation wire, type БПВЛ.

The plastic case of the lamp has an extension sleeve wit two light filters made of "black" uviol glass and is provide with a hinged base.

All the inscriptions, indexes and nameplates of normal reference or instructive nature have green luminescence, and those of alarm and emergency nature have orange luminescence.

The aircraft is equipped with 16 АРУ.ОЛ-45 systems with rheostats, type РУФО-45 (See Table 9).

Table 9

Location of АРУФОЛ-45 Systems and РУФО-45 Rheostats

Nos	Location of АРУФОЛ-45 system	Location of РУФО-45 rheostat	Remarks
1	2	3	4
1	Starboard of front pressurized cabin, on frame No.2	Overhead electric control board of navigator	Used for illumination of sight, instrument panel and right-hand console of navigator
2	Front cabin ceiling, frame No.3	Overhead electric control board of navigator	Used for illumination of sight, instrument panel and right-hand console of navigator
3	Front cabin ceiling, frame No.4	Do	Do
4	Co-pilot's control wheel	Engine control station (console) of co-pilot	Used for illumination of instrument panels of pilots
5	Do	Do	Do
6	Pilot's control wheel	Engine control station (console) of pilot	Do
7	Do	Do	Do
8	At frame No.8, port side	Do	Together with КИСРК-45 fixtures serves for illumination of co-pilot's engine control station
9	Front cabin ceiling, frame No.8	Engine control station of pilot	Together with КИСРК-45 fixtures serves for illumination of overhead electric control board of pilots and fuel control board

The lamp is fixed in the desired position by means of a nut and a locking nut.

All the three taxiing lamps are engaged simultaneously from a common switch, type B-45, (Fig.51) which is mounted on the overhead electric control board of the pilots. The taxiing lamps are fed from the normal power supply bus bar through an A3C-10 circuit breaker installed on the pilot's circuit breaker control panel.

Each ФР-100 taxiing lamp installed on the aircraft illuminates the landing strip at a length of 15 to 20 m. ahead from the pilots' cabin.

Landing Lamps

The two extension landing lamps, type ЛЭСВ-45, (Fig.51) are mounted in the belly section of the fuselage at frame No.11. The extensible part of the lamp consists of a case and a special reflecting bulb rated for 26 V, 600 W; the bulb incorporates a filament lamp, a reflector and a protective cover glass. The bulb of the lamp is parabolically-shaped, and the inner reflecting surface of the bulb is mirror-coated. The lamp actuator (See the Diagram, Fig.52) consists of a series-wound reversible motor, a reduction unit and a disengaging contact assembly.

The lamp is designed to be fed from single-wire aircraft electric mains. The lamp is automatically switched on when being extended, and switched off while being retracted. With the lamps in the extreme extended or retracted position, the electric motor of the actuator is automatically disengaged by means of limit switches provided inside the landing lamp actuator.

The landing lamps are controlled by means of a 2ПП-45 change-over switch (See Fig.40) mounted on the overhead electric control board of the pilots. The landing lamps are fed from the normal power supply bus bar. The lamp control circuits are protected with two A3C-5 circuit breakers, and

the power supply circuits of the lamps are protected with two circuit breakers, type A3C-30. All the circuit breakers are installed on the pilot's circuit-breaker control panel.

Main Technical Data of Landing Lamp, Type ЛЭСВ-45

Maximum candle-power	not less than 400,000 candles
Dispersion angle of lamp:	
in horizontal plane	not less than 12°
in vertical plane	not less than 8°
Extension angle (same for right and left lamps)	86°30'
Time of lamp extension and retraction	not more than 12 sec.
Maximum allowable time of continuous operation	5 min.
Service life	6 hours of operation
Weight of lamp with actuator	3.5 kg

When voltage is 10 per cent larger than rated, the lamp may be operated for 3 min.

When extended, the landing lamps, type ЛЭСВ-45, illuminate the landing strip of 40 to 60 m. ahead from the pilots' cabin.

Formation Lights

The top and bottom formation lights are installed along the fuselage and on the landing gear cowls along the wing span to form a burning Tee in the flight. The formation lights are mounted flush with the skin. Each formation light, type ПСС0-45, consists of an aluminium case the inner surface of which serves as a reflector, a holder mounting with a single-contact lamp holder for a СМ-30 bulb rated for 28 V, 0.17 A, and a dark-blue light prismatic refractor which at the same time serves as a light filter.

Main Technical Data of Formation Lights, Type ПСС0-45

Maximum candle-power ..... not less than 5.5 colour candles. With light set horizontally, the beam is directed backward and 45 to 50° upward from reverse flight direction

Light visibility range in maximum intensity direction under fair night conditions ..... some 3 km.

Angular width of light beam ..... some 20°

To avoid overheating and damage to the refractor, never engage the lights at parking for long periods of time.

The top and bottom formation lights are controlled by means of B-45 switches installed on the overhead electric control board of the pilots (See Fig.40). The circuits of the top and bottom formation lights are protected with two A3C-2 circuit breakers mounted on the pilot's circuit breaker control panel and connected to the normal power supply bus bar.

For the circuit diagram of the formation lights see Fig.52.

Navigation Lights

The tip fairings of each wing mount front and rear navigation lights. Two red wing navigation lights, type БАНО-45, are provided on the left wing tip, and two green wing navigation lights of the same type are installed on the right wing tip. The wing navigation lights are bolted in recesses closed with plexiglass covers. The lights use СМ-22 bulbs rated for 28 V, 24 W with a candle-power of 21 candles.

Installed in the tail section of the fuselage below the stern cowl is a white tail navigation light, type ХС-39, with СМ-15 bulb rated for 26 V, 10 W.

The wing and tail navigation lights are controlled by means of a B-45 switch (See Fig.52) installed on the overhead electric control board of the pilots. The navigating light circuit is protected with an A3C-5 circuit breaker mounted on the pilot's circuit breaker control panel and connected to the normal power supply bus bar.

11. SIGNALLING SYSTEM

The aircraft is provided with light and sound signalling systems. The light signalling system uses various-colour signal (warning) lights, type СЛЦ-51, which are installed on the consoles, control stations, instrument panels, control panels and control boards.

For the types, locations and operating conditions of the signal (warning) lights see Table 10 below.

Table 10

Light Signalling System

Nos	Object of indication	Number of lights	Type of light	Operating conditions	Nature of signal	Location	Remark
1	2	3	4	5	6	7	8
1	Engine starting readiness	2	СЛЦ-51, green	Exhaust gas shutters of turbo-starter open	Continuous shining	Engine starting control board on pilot's engine control station	
2	Turbostarter oil pressure	1	СЛЦ-51, green	Turbostarter oil pressure exceeds 3.5 kg/cm^2	Do	Turbostarter control panel	
3	Tank connection order	4	СЛЦ-51, blue	First-group light flashes up when fuel tank selector switch is placed to AUTOMATIC, and when boosters are engaged. Other lights flash up in turn as soon as 200 lit. of fuel remain in previous tank group	Do	Fuel control board	
4	Fuel remaining for 30 and for 15 min. of flight	4	СЛЦ-51, red	Two red lights flash up to indicate fuel remaining for 30-min. flight and two other lights - to indicate fuel remaining for 15-min. flight	Continuous shining	Fuel control board and pilot's instrument panel	
5	Fuel pump operation	12	СЛЦ-51, green	With fuel pump operating, as soon as pressure of 0.3 to 0.35 kg/cm^2 is built up in system	Do	Fuel control board	
6	Fuel shut-off valves open	2	СЛЦ-51, green	With fuel shut-off valves open, from beginning of engine starting till engine stoppage	Do	Do	
7	Fire	6	red	As soon as fire-fighting system is engaged when tempera-	Do	Do	

1	2	3	4	5	6	7	8
				ture in overheat warning unit area reaches 140 - 170°C, or upon actuation of operating button			
8	Drag chute release	2	СЛЦ-51, green	When drag chute is released	Continuous shining	Instrument panels of pilot and co-pilot	
9	Pressure drop in normal and emergency hydraulic systems	2	СЛЦ-51, red	As soon as pressure in normal hydraulic system drops below 100 kg/cm^2, and in emergency hydraulic system below 130 kg/cm^2	Do	Middle electric control board of pilots	
10	Operation of automatic brake control unit	1	СЛЦ-51, blue	At sharp wheel braking, with control unit switch closed	Light is blinking	Do	

1	2	3	4	5	6	7	8
11	Cannon position while landing	2	СЛЦ-51, blue	With lowered cannon of lower and stern mounts	Continuously shining	Pilot's instrument panel	
12	Position of landing gear and tail skid	8	СЛЦ-51, five green lights and three red lights	Three green lights indicate extended position of L.G. legs, and three red lights - retracted position of L.G. legs. Two green lights indicate retracted position of tail skid	Do	Middle electric control board of pilots and electric control boards of radio-gunner and gunner	
13	Neutral position of aileron and rudder trim tabs	3	СЛЦ-51, white	When aileron and rudder trim tabs are neutral	Do	Pilot's instrument panel and aileron synchronization control station	
14	MACH LIMIT	2	СЛЦ-51, red	At velocity head of 2300 kg/m^2, low altitudes; at M=0.86, high altitudes	Do	Instrument panels of pilots	

...

S-E-C-R-E-T

1	2	3	4	5	6	7	8
15	Engagement of standby gyro horizon set	1	СЛЦ-51, red	When standby gyro horizon set is engaged by pilot or radar operator	Continuous shining	Pilot's instrument panel	
16	Uncaged remote-indicating compass	1	СЛЦ-51, green	With switch set to UNCAGED (РАЗАРРЕТИР)	Do	Overhead electric control board of navigator	
17	Camera hatch, open, positions of camera tilting unit for RECCE BOMBING CONTROL	3	СЛЦ-51, green, white, yellow	1. Green light is on, with camera hatch open	Do	Navigator's right-hand console	
				2. White light flashes up when tilting unit passes zero position in RECCE mode of operation	Light is blinking		
				3. Yellow light shines when tilting unit is operating for BOMBING CONTROL, at tilt angles of 0, 10, 15, 20 and 25°	Continuous shining		

1	2	3	4	5	6	7	8
18	Operation of tail unit de-icers	1	СЛЦ-51, white	When outer sections de-icers are engaged	Light comes on for 40 sec. to go out for 80 sec.	Co-pilot's instrument panel	
19	Cabin pressure drop	5	СЛЦ-51, yellow	As soon as pressure drop reaches the value of altitude set on dial within 1000 to 5000-m. range	Light is blinking	Navigator's oxygen control panel, instrument panel of pilot, oxygen control panel of radar operator, instrument panel of radio-gunner, and electric control board of gunner	

S-E-C-R-E-T

Signal Flare System

External light signalling is effected with signal flares of red, yellow, green and white colours. The signal flare system consists of three signal flare control stations and three signal flare launchers, type SKCP-46.

The signal flare control station is a metal box mounting four buttons and a switch. By turning the button head it is possible to set the flag of red, yellow, green or white colour to match the colour of the corresponding signal flare.

The flare control stations are installed on the signal flare control board which has rectangular openings, one for each control station.

The control stations are lettered A, B and P which designate the control stations to ensure correct use of the flare launchers.

The signal flare control board is installed on the navigator's right-hand console (Fig.53).

The signal flare launcher, type SKCP-46, is a metal case which houses the plastic body of the flare tube set. Each set is loaded with four signal flares and primers.

Two signal flare launchers (A and B) are installed in the front non-pressurized section of the fuselage between frames Nos 20 and 22, starboard, and the third container (B) is mounted between frames Nos 21 and 22, port side.

IMPORTANT: Upon loading the flare launchers with signal flares, set the flags of each control button so that their colour would correspond to their respective flare colours. The launchers must be loaded when the buttons are pulled backward, with the signal flare control station switch OFF.

The system is energized (See the Diagram, Fig.54) from the normal power supply bus bar through an A3C-5 circuit breaker installed on the co-pilot's circuit breaker control

panel. Before launching the flares it is necessary to close switches 2 installed on the signal flare control station.

When button 3 of the flare control station is pressed, the primer is punctured by a special mechanism, and the flare is launched from the launcher.

Cabin Pressure Drop Warning and Flap and L.G. Position Indication

To warn the aircraft crew about dangerous pressure drop in the pressurized cabins in high altitude flying, the aircraft is equipped with two cabin pressure drop warning units, type BC-46, two sirens, type C-1, and five yellow warning lights, type CMH-51.

The cabin pressure drop warning unit closes the electric circuit of the sound and light signalling systems to warn the crew of the necessity of resorting to the oxygen equipment.

The warning unit, type BC-46, is a block of four diaphragm assemblies which is connected with the moving contact of the electric circuit. When the cabin pressure drops below the prescribed value the diaphragm assembly block closes the contacts of the circuit to apply electric signals to the buzzer relay, type PM-12.

The warning unit is adjusted to produce signals at altitudes from 1000 to 5000 m.

Main Characteristics of Warning Unit, Type BC-46

The warning unit should produce continuous light and sound signals beginning from the moment the cabin pressure drops to the value of altitude set on the dial.

The range of adjustment (the range of pressure with respect to the International Standard Atmosphere) to start the warning unit operation is 1000 to 5000 m.

The operating temperature range of the instrument is from plus 50°C to minus 60°C. The instrument error at dial graduations 1, 2.5, 3, 3.5, 4, 4.5 and 5 km. under normal temperature conditions does not exceed ±150 m. The warning unit is operative under vibration conditions with frequencies of 20 to 80 c.p.s. and at overloads of up to 2.5 g.

The electric contacts are sure to withstand up to 1000 engagement cycles.

The weight of the instrument is not over 450 gr (the plug connector inclusive).

The pressure drop warning units are installed as follows: in the front cabin, at frame No.5, starboard, and in the rear cabin at frame No.75, starboard.

Cut into the circuit of each pressure drop warning unit to produce intermittent light and sound signalling is a buzzer relay, type РЛ-12 with two capacitors, type КЭ-1-50- $\frac{50}{\text{ohm}}$ v.

The РЛ-12 relays and the capacitors are installed in the sound signalling system relay boxes. The relay boxes (Figs 55 and 56) are mounted in the front prescurized cabin on the left-hand shelf of the radar operator, and in the rear pressurized cabin at frame No.73, starboard.

For the electric supply circuit of the signalling system see Fig.57.

B-45 switches 3 and 5 of the signalling system are installed on the rheostat board (Fig.58) of the co-pilot's engine control station and on the radio-gunner's electric control board (see Fig.44).

When a differential pressure corresponding to the altitude set on the instrument dial is built up, the contacts of cabin pressure drop warning units 9, type BC-46, (Fig.57) close to energize the windings of respective РЛ-12 relays 8 and capacitors 7. The РЛ-12 relays operate to engage for intermittent operation three yellow lights 6 and C-1 siren 2 which are installed in the front cabin, or two yellow lights 6 and C-1 siren 4 installed in the rear cabin. Simultaneously with engaging the siren and warning lights, the РЛ-12 relay breaks

the power supply circuit of its own field winding, and therefore the return spring forces the relay contacts back to their initial position to close the circuit of the field winding and of the capacitors again.

This ensures intermittent sounding of the siren and blinking of the warning lights.

The pressure drop warning lights of the front cabin are installed on the oxygen control panels of the navigator and radar operator, and on the pilot's instrument panel. The siren, type C-1, of the front cabin is mounted on the port side, at frame No.9. In the rear cabin the warning lights are located on the electric control board of the gunner (Fig.59) and on the instrument panel of the radio-gunner; the siren of the rear cabin is installed on the starboard, at frame No.71.

Sound signalling in the aircraft is accomplished with aircraft sirens, type C-1, which sound either continuously or intermittently.

Intermittent signals are initiated by cabin pressure drop warning units, type BC-46.

Continuous signals are initiated by:

(a) the МКВ-2 actuator installed on the flap transmission shaft at frame No.33 and the front ВК2-142Г limit switches installed on the co-pilot's engine control station - in case the aircraft takes off with flaps not extended or extended but not through the required angle;

(b) the rear blocking contacts, type ВК2-142Г installed also on the co-pilot's engine control station, and the L.G. extended position limit switches - in case of throttling down with the landing gear retracted at landing.

The limit switches of the МКВ-2 actuator are adjusted so that one of them with its cam opens the contacts when the flap deflection angle reaches $19^{\circ+1^{\circ}}$ and closes them again when the flap is deflected through more than 23°. The second limit switch, by means of the second cam, opens its contacts when the flap deflection angle is less than 19° and closes them

again as soon as the deflection angle reaches $23^{\circ}_{-1^{\circ}}$. Consequently, when the flaps are not extended through the take-off angle (between $19^{\circ+1^{\circ}}$ and $23^{\circ}_{-1^{\circ}}$), one or two limit switches of the MKB-2 actuator are always closed.

When taking off, the co-pilot or pilot moves the throttle control levers forward and, in this way, closes the contacts of front limit switches 12, type BK2-142P, installed on the co-pilot's engine control station. With these limit switches closed, current from the dual power supply bus bar of the co-pilot's circuit-breaker control panel is applied through the closed contacts of relay 1 and closed contacts of limit switches 10 of the MKB-2 actuator (when the flaps are not extended or are extended but not through the required angle) to the field winding of PN-2 relay 13 which disconnects the intermittent signalling. This relay operates to connect the C-1/2 siren of the front pressurized cabin for continuous sounding which will be on until the flaps are extended by the take-off angle.

As soon as the flaps are extended through $19^{\circ+1^{\circ}}$ to $23^{\circ}_{-1^{\circ}}$ two limit switches 10 of the MKB-2 actuator will break the minus circuit of relay 13 and siren 2, and the siren will stop sounding. The siren can stop sounding also in case the circuit of siren 2 and relay 13 are broken by limit switches 11 i.e. when one or both of the throttle control levers are moved by the pilot away from the position corresponding to the take-off procedure.

If at least one of the L.G. legs is not extended, PN-2 alarm relay 1 operates to open the circuit of limit switches 10 of the MKB-2 actuator. When one or both of the throttle control levers are placed to the low throttle position (at landing), one or two BK2-142P limit switches 12 close their contacts to energize PN-2 relay 13 (disconnecting the intermittent signalling) which, like in the first case, engages siren 2 of the front pressurized cabin for continuous sounding until all the three L.G. legs are fully extended (See the Diagram, Fig.57). The siren sounding may be stopped in this

case by retracting both of the throttle control levers from the positions corresponding to the landing procedure.

When the aircraft glides at high altitudes with one or both of the throttle control levers placed to the low throttle positions, or in case of stoppage of one of the engines, the siren sounding can be discontinued by pressing one or both of the manual disengaging buttons of the siren which are installed on the right-hand engine console (control station). The two manual disengaging buttons are mechanically linked with the rear limit switches, type BK2-142P, each of them opens the minus circuit of siren 2 or relay 13 when the respective button is pressed.

The front BK2-142P limit switches are not provided with manual disengaging buttons since under normal flight conditions (L.G. retracted) during augmented power engine operation the minus circuit of siren 2 and relay 13 will be always kept open by PN-2 blocking alarm relay 1, i.e. siren 2 of the front pressurized cabin will be silent.

Chapter 2

RADIO EQUIPMENT

GENERAL

The radio equipment carried by aircraft Ty-16 is designed for communication, radio navigation, and radio detection and ranging purposes.

1. Communication facilities are intended to provide communication of the airplane with other aircraft and with ground radio stations, to provide the communication means for the aircraft crew, and to send the distress signals.

The airplane mounts:

(a) short-wave communication radio set 1-PCB-70 with receiver PC-9 for two-way air-to-air and air-to-ground communication;

(b) short-wave command radio set 1-РСБ-70М with receiver УС-9Д for command communication within the aircraft formation and for air-to-ground communication;

(c) ultrashort-wave command radio set РСИУ-3Н for command radio set РСИУ-3М for command communication within the aircraft formation and for communication with the flight control officer;

(d) aircraft interphone system СПУ-10 for communication between the members of the crew and for external communication (See Table 11);

(e) emergency transmitter АВРА-45 for sending the distress signals.

2. Radio navigation equipment is intended for solving the navigation problems under various weather conditions.

The aircraft mounts:

(a) automatic radio compasses АРК-5 No.1 and No.2 for flying the aircraft by homing and broadcasting stations and radio beacons, for determining the position of the aircraft and for instrument landing judgment;

(b) radio altimeters РВ-17М and РВ-2 of low and high altitudes for determining the true altitude of flight;

(c) instrument landing equipment operating by the signals of the ground facilities. It comprises set of aircraft equipment of the СП-50 system (course receiver КРП-Э, glide slop receiver ГРП-2, receiver and transmitter of radar ranging unit СД-1, and marker receiver МРП-48П).

3. Radar equipment is intended for identification of aircraft, for aimed bombing and aimed firing.

Table 11

Control of Radio Equipment Installed in Aircraft

Crew members \ Radio facilities	Command set 1-РСБ-70М	Communication set 1-РСБ-70	АРК-5 No.1	АРК-5 No.2	РСИУ-3Н	РВ-2	РВ-17М	ГРП-4	ГРП-2	МРП-9	СП-50 (ИЛ-28) МРП-48П	СД-1	Transponder ПРС-1	СПУ-10
Navigator	+	+	+○	+	+	+○	+							+
Co-pilot	+○	+	+	+	+○				+	+	+			+
Pilot	+	+	+○	+	+○	+○			+○	+○	+	+○	+○	+
Radar operator	+	+			+		+○							+○
Radio-gunner	++	+○			+									+
Gunner					+								+○	+

Note: + stands for equipment that may be used by the crew member.

+ ○ stands for equipment that may be used and controlled by the crew member.

++ the radio operator may operate the transmitter of command set 1-РСБ-7С with the aid of the key only (the tuning is done by the co-pilot).

The aircraft carries the following equipment:

(a) IFF system consisting of a transponder;

(b) radar bombsight ГПП-4 intended for searching and detecting enemy objects under no optical visibility condition, for solving the navigation problems with the aid of ground radars and for aimed bombing and automatic bomb release;

(c) radar gunsight ПРС-1 for aimed firing at targets appearing in the tail zone under any visibility conditions.

Depending on the problems to be solved, every member of the crew can control or make use of the radio equipment installed in the aircraft according to Table 11.

Folded-dipole antenna is provided for short-wave set 1-РСБ-70М, and stranded wire antenna for communication set 1-РСБ-70. Ultrashort-wave set РСИУ-3М having an additional receiver is provided with two surface antennas.

The antenna of glide-slope receiver ГРП-2 is glued to the inside of the front glass panel of the navigator, and the antenna of radio compass АРК-5 No.2, on the inner surface of the operator's blister.

Antennas of the course receiver КРП-2, radar sights РБП-4 and ПРС-1 are installed under special fairings.

Loop antennas of automatic radio compasses АРК-5 No.1 and No.2 and the antenna of marker receiver МРП-48П are mounted inside the fuselage and are not stream-lined by the airflow. Antenna of automatic radio compass АРК-5 No.1 is placed inside of a semi-fairing made of textolite.

Altimeters РВ-17М and РВ-2 have a common antenna.

Antennas of transponder СРО, radar ranging unit СД-1, altimeter РВ-17М and radio set 1-РСБ-70М projecting from the fuselage are streamlined.

For the layout of antennas of the aircraft radio equipment see Fig.60.

115 V, 400 c.p.s., A.C. is fed to the radio facilities from inverter ПО-4500. The D.C. feed circuits of the radio equipment are protected by circuit breakers, and the A.C. feed circuits - by means of fusible cutouts СП placed on various panels of the aircraft power supply system. The radio facilities are protected by fusible links and cutouts set inside of them.

Filters НЖУС-9, О-14А, interphone system filter, capacitor КБМ-31, КБП and others are used as additional noise suppression means. Receivers УС-Д and УС-9Д are provided with crystal filters for noise protection purposes, and receiver of РСИУ-3М with electronic noise suppressor.

The radar gunsight ПРС-1 employs noise suppression system which comprises special unit and ultrashort-wave delay lines.

Section I

RADIO COMMUNICATION FACILITIES

The aircraft is equipped with radio communication facilities to provide communication with ground radio stations and other airplanes, for command communication during formation flight, for communications with flight control officer, for intercommunication between the aircraft crew members, and for sending signals of distress.

The arrangement diagram of the communications radio sets is shown in Fig.61.

1. COMMUNICATION RADIO SET 1-РСБ-70 (Р-807)

Purpose and Delivery Set

Short-wave communication radio set 1-РСБ-70 (Fig.62) is designed for long-range telephone and telegraph communication of the aircraft crew with ground stations and other airplanes.

The radio set includes:

(a) transmitter 1-РСБ-70;
(b) dynamotor У-600 with filter;
(c) receiver УС-9;
(d) stranded wire antenna;
(e) telegraph key panel;
(f) microphone;
(g) box with spare valves for the transmitter;
(h) box with spare valves for the receiver;
(i) monitoring selector.

Radio set 1-РСБ-70 is installed in the rear pressurized cabin in front of the radio-gunner who operates it (Fig.63).

The communication range of aircraft Ту-16 with ground stations РАС-КВ and receiver Р-250 is up to 3000 km. at an altitude of 10,000 m.

The power consumed by the transmitter does not exceed 1250 W.

The power in the antenna engaged for telephone or telegraph communication is within 70 to 100 W.

The speed of the telegraph keying is 30 words per minute.

Non-linear distortion factor does not exceed 13%.

Frequency band range is from 2500 to 18100 kc/s (120 to 16.5 m.).

Additional medium-wave band ranges from 200 to 1500 kc/s (1500 to 200 m.).

Performance altitude of the set operating in depressurized cabin is up to 12000 m.

The set provides control of its operation by monitoring at high and low frequencies.

Types of communication:

- simplex (not used);
- half-duplex (transmission and reception at the same or adjacent frequencies).

The whole set weighs some 60 kg.

The radio set is operated from the front panels of the transmitter, receiver and from the telegraph key panel. Switching on and change from low-frequency monitoring to high frequency monitoring and vice versa are done with the aid of the selector on the radio operator's electric panel.

The transmission and reception are carried out through the throat microphones and telephones of the interphone system CHY-10 and from the telegraph key panel. If the intercom system is inoperative, the radio operator may use carbon telephone, or connect the throat microphones and telephones of his headset to the transmitter receptacles with the aid of extension cable.

Purpose, Installation and Principle of Operation of Radio Set Units

Short-wave transmitter 5 (Fig.63) is mounted on brackets in a tilted position, in the plane of frame 72. It is attached

with the aid of removable shock mount consisting of a frame with four shock absorbing pads and limiters, and middle and upper carriages.

The transmitter may be used for telegraph communication through sustained oscillations, or voice-frequency carrier, and for telephone communication through a microphone.

The transmitter can be automatically set for eleven given frequencies (wave lengths) previously tuned and fixed.

Communication set 1-2CB-70 (transmitter and receiver) is connected to the folded-dipole antenna.

In case the transmitter fails, the radio operator may connect his telegraph key to the command set by means of the selector on the electric panel and communicate with the ground via the command set transmitter at predetermined frequencies.

Dynamotor V-600 with filter feeding the high voltage circuits (screen grid plates of the valves and bias circuits) consumes 700 to 1250 W D.C. supplied from the aircraft mains. The high and low-voltage circuits of the dynamotor are protected with four fusible cutouts.

The dynamotor with a filter (Fig.63) is installed on the starboard side of the cabin on the pressurized pocket next to frame 75. It is mounted on the filter box whose bottom is provided with a shock absorbing fixture. The filter box is attached to the bracket riveted to the pressurized pocket with the aid of a crosspiece.

Receiver. Receiver VC-9 (15) (See Fig.63) is an eight-valve superheterodyne intended for telephone transmission and for sustained oscillation and voice-frequency carrier telegraphy. It has automatic and manual sensitivity controls and crystal filter for narrowing the transmission band when noises interfere with reception.

Receiver wave band:

- short waves - 1.5 to 18 Mc.p.s. (200 to 16.66 m.);
- long waves - 200 to 500 Kc.p.s. (1500 to 600 m.).

All the frequency (wave) band is devided into 6 sub-bands, one of them for long waves.

When engaged for telephony, the sensitivity of the receiver is not less than 15 μV and 7 μV (the input voltage being 15 V), and when engaged for telegraphy, not less than 6 μV and 3 μV for long and short waves respectively.

The housing of the receiver accommodates dynamotor У-18-2. The dynamotor is intended for power supply to the high voltage circuits when the УС-9 is operating (irrespective of the transmitter).

The receiver controls are concentrated on the front panel.

The receiver of the communication set is installed in the plane of frame 72 under the transmitter on radio operator's sliding table (Fig.63). The table can be shifted together with the receiver along the vertical guides from the lower operating position to the upper non-operating position and can be fixed in the extreme positions. The table also mounts the telegraph key panel.

The receiver together with the shock mount provided with four shock absorbers is secured to the table with the aid of eight bolts. The attachment of the receiver to the shock mount is of quick-release type. The pins fitted on the jacket (case) bottom enter the shaped slots of the shock mount upper frame, the two latches fixed to the angle piece in the lower front portion of the jacket locking the receiver (preventing its falling out).

Telegraph key panel. Telegraph key panel 11 (See Fig.63) is mounted on the radio operator's table to be operated by his right hand. It comprises a base plate and a cover plate. On the base plate is placed telegraph key and clamp with antenna mode-of-operation selector secured to it. The antenna selector is intended for changing from the transmission over to reception when engaged for simplex functioning.

The key panel is secured to the cast table of the radio operator.

Spare valve boxes 1 and 2 (Fig.63) of the transmitter and receiver are installed on a shelf over the transmitter and attached to the shelf by means of shock absorbing rubber cord.

Dynamotor У-600 of the communication radio set is fed from the aircraft mains (normal busbar of the circuit breaker panel, rear cabin) via circuit breaker A3C-50. The same panel also serves to feed receiver УС-9 (without a fusible cutout in the mains).

Wiring. The lead-in running from the antenna to the transmitter is made of bare БПВМ wire, 21 sq.mm. It is insulated with R.P. plastic beads (textolite beads being furnished on the aircraft of earlier make).

Receiver lead-in 9 (Fig.63) running from terminal A to terminal АП of transmitter 5 is made of wire ПВМ, c.s. 1.3 sq.mm, laid along the radio operator's instrument panel on ebonite insulators.

The feeding cables of communication set 1-РСБ-70 running from the dynamotor to the transmitter are secured with metal clamps having rubber padding and bonding strips.

The cable runs along the starboard side of the rear pressurized cabin and is secured by means of attachment bolts that secure the electric cables, too, but the electric and feeding cables are separated with the aid of special bushings.

The wires running from the transmitter to monitoring selector 7 mounted on the port side are laid along the load-carrying beam together with the line of electric wires. Other cables also run along the path of the bunched electric wiring.

2. COMMAND RADIO SET 1-РСБ-70К (Р-808)

The command radio set 1-РСБ-70К (Fig.64) is intended for telephone and telegraph communication with ground command radio stations and with other airplanes in flight.

The radio set 1-РСБ-70М includes:

(a) transmitter 1-РСБ-70М;
(b) dynamotor У-600 with filter;
(c) transmitter remote control panel;
(d) remote control receiver УС-9Д;
(e) receiver remote control panel;
(f) folded-dipole antenna;
(g) box with spare valves for the transmitter;
(h) box with spare valves for the receiver.

The set is installed in the front pressurized cabin on the starboard panel support of the radio operator between frames Nos 9 and 12 (Fig.65).

The set is operated by the co-pilot by means of the remote control panels of transmitter and receiver.

The set can be engaged for telephone and telegraph communication, the latter being done with the aid of the key on the remote control panel and of the radio operator's key.

Performance Data

Communication range when communicating with ground station РАС-КВ is 120 km. at an altitude of 1000 m., and 350 km. at an altitude of 10,000 m.

Unlike the communication radio set, the command set is intended for half-duplex service and can be controlled from distance.

The operation of the set is checked (by monitoring) only at low frequencies and no monitoring selector is provided.

The transmission and reception are done with the aid of the throat microphones and the telephones of intercom СПУ-10.

Purpose, Location and Operation of the Set Units

Transmitter. Transmitter 13 of the command radio set 1-РСБ-70М has eleven fixed wave lengths (frequencies).

The remote control system of the transmitter is intended to turn the transmitter ON and OFF and to set the desired mode of operation (telephony, telegraphy, and voice-frequency carrier telegraphy).

The change-over time from one fixed frequency to another is 25 - 30 seconds.

Note: The transmitter of the command set can be used, for duplex service only. The telegraph key panel is not mounted and wire "25" is shorted to the chassis.

The transmitter is secured to the panel support shaped members with 12 screws. The antenna lead-in of the transmitter is similar to that of the communication set transmitter.

Dynamotor У-600 with filter 20 (Fig.65) is mounted on the panel support under the receiver, the crosspiece of the filter box shock-mounted portion being fixed to the panel support shaped members with four bolts.

Transmitter control panel. The remote control panel of the transmitter (Fig.65) is installed on the starboard side between frames Nos 7 and 8 above the co-pilot's motor panel. The base (bottom) of the panel is secured to the board with the aid of three screws. The panel is held to the bottom by four ever-set screws.

The front wall of the panel mounts:

(a) starting and mode-of-operation selector;
(b) channel selector;
(c) indicating lamp holder.

Mounted on the upper wall of the panel is contactor, and on the lower one, receptacle receiving the microphone plug.

Receiver УС-9Д controlled from the distance is used for radio telephone and radio telegraph communication of the aircraft. Its dimensions and performance data do not differ from those of receiver УС-9. The shock mount of receiver 19 (Fig.65) is secured to the starboard panel support under the transmitter by means of eight bolts.

The fairlead of the command receiver and communication set are of the same type. The fairlead is attached to the shaped members under the transmitter and to the front wall of the panel support with the aid of base insulators made of ebonite (or organic glass in the aircraft of earlier make). Remote control panel 25 allows to govern receiver УС-9Д from a distance. It is installed on the tilted portion of the co-pilot's motor panel above the remote control panel of the transmitter.

Folded-dipole antenna. The folded-dipole antenna of the command set (Fig.66) is a silver-coated brass tube, 8x12 mm, 6-m. long, secured some 100 mm off the fuselage between frames Nos 10-22.

Power supply, protection and installation of the set. Dynamotor У-600 is fed from the aircraft mains, via the power leed-in on frame No.12.

The remote control system receives 115 V, 400 c.p.s., A.C. from the operator's fusible cutout panel via the fusible cutout СП-2. Direct currents is fed to the filter ПФУС-9 from the operator's circuit breaker panel.

Filter ПФУС-9 is mounted in the same way as the filter of communication set receiver УС-9.

All the bunched wires and cables of the command set 1-РСБ-70М are laid along the starboard side between frames Nos 7 to 10 and along the right panel support of the equipment between frames Nos 10 to 11.

The bunched wires of the remote control panel are secured to the co-pilot's motor panel. The bolts are screwed into the motor panel.

The cable running from the transmitter to the dynamotor is secured to the panel support shaped member by means of clamps with bonding strips. Greater part of the radio set wires is laid along the electric wire line and has common attachment fixtures together with the electric wires.

2. COMMAND RADIO SET РСИУ-3М

Ultrashort-wave simplex transceiving radio set РСИУ-3М is intended for telephone mode of operation of the command communication between the aircraft in the formation and the flight control radio set. The set is provided with quartz-crystal frequency control.

The РСИУ-3М set (Fig.67) includes (a) transmitter; (b) two receivers; (c) supply unit; (d) two control panels; (e) three boxes with quartz-crystal sets; (f) measuring unit (in the set of one of four aircraft);

All units of the radio set, except the control panels, buttons and antennas, are located in the rear pressurized cabin. The set is operated by the pilot and co-pilot.

Performance Data

When communicating with the ground radio set of the РАС-УКВ type, the ultrashort-wave set РСИУ-3М covers the following ranges of communication depending on the flight altitude:

Flight altitude, m.	Communication range, km.
1000	120
2000	160
5000	230
10,000	350

At altitudes over 500 m., the air-to-air communication range covers 120 km. at least.

The frequency band of the set is 100 to 150 Mc.p.s. (2 - 3 m.) with quartz-crystal frequency control of the transmitter and receivers which ensures fixed frequency communication.

The remote control of the radio set is accomplished with the aid of buttons pressed on two remote control panels.

The radio set allows pre-tuning to any four frequencies of the band so that any of them can be used for communication purposes while in flight.

Time of change-over from one wave to another does not exceed 3 sec.

The second receiver of PCMY-3M can be tuned to any four frequencies of the band differing from the tuning frequencies of the transmitter and receiver No.1.

The outputs of receivers Nos 1 and 2 are connected to the telephones of intercom CMY-10 through the control panels.

The reception is changed over to transmission by means of four-contact button TK-4M marked RECEPTION-TRANSMISSION (ПРИЕМ-ПЕРЕДАЧА) and set on the pilot's control column (name plate RADIO SETS). The button connects to the plug 9-301 on the control panel.

The time of change-over from reception to transmission is 0.5 second.

The power consumed when engaged for transmission does not exceed 415 W, and when engaged for reception, 270 W with normal voltage across the aircraft mains.

The microphone and telephone are connected to the transmitter and receiver via the interphone set of the co-pilot, the remaining interphone sets being parallel-connected to the latter.

Purpose, Installation and Operation of Radio Set Units

The eight-valve transmitter has 100 to 150 Mc.p.s. frequency band with quartz-crystal frequency control.

The transmitter power is 6 W.

The shock mount of transmitter 5 (Fig.68) is installed on the support between frames 69-70, starboard. The transmitter face panel is set vertical and faces backward. The face panels of the transmitter and receivers are protected with a cover.

Receiver No.1 (Item 4 in Fig.68) is mounted in the port side portion of the aircraft on the support where the transmitter is installed.

Receiver of PCMY-3M is a 13-valve telephone superheterodyne with quartz-crystal frequency control. Four fixed frequencies (channels) should be adjusted in advance. The frequency band covers 100 to 150 Mc.p.s.

The receiver is remotely controlled, the channel being selected and the volume controlled on the control panel.

The receiver has an electron noise suppressor which automatically cuts off the receiver when there is no carrier frequency of the other party (locks the low frequency amplifying valve), and cuts it in when the carrier frequency appears.

The receiver can be tuned with the aid of unit "M" (measuring unit) without a signal generator.

Receiver No.2 (Item 1 in Fig.68) is arranged on the upper support over receiver No.1.

The receiver is used as a stand-by one to promote the functioning of the set, and also as a regular receiver.

Receiver No.2 is attached in the same way as transmitter and receiver No.1.

The supply unit comprises two selenium rectifiers 2 for providing direct current (from inverter NO-4500) and generating the following voltages:

(a) +310 V to be applied to the valve plates when the set is engaged for transmission and +275 V when engaged for reception;

(b) -105 V to be applied to the bias circuits when the set is engaged for reception and -120 V when engaged for transmission.

The valve filament current is supplied from the aircraft mains. The supply unit is installed on the upper support right of receiver No.2 (above the transmitter) and fixed to the support shaped members.

Control panel of transmitter and receiver No.1 and control panel of receiver No.2 are installed in the upper portion.

(along the aircraft axis) on the canopy beam, within easy reach of the pilots. The control panels can be easily removed.

Quartz crystal boxes 3 (Fig.63) are mounted on the spare valve box for transmitter 1-PCB-70, between frames Nos 72-73, on a common base which is secured to the support together with the transmitter spare valve box with the aid of two shock-absorbing cords.

Unit "M" (measuring unit) is intended for tuning the receiver without a signal generator, for tuning the transmitter according to the current values of the tripler, and for controlling the antenna current. Unit "M" is installed on the starboard side of the aircraft between frames Nos 63-64, on a special bracket with rubber gaskets, and is fixed by means of removable shock-absorbing flexible cord.

Transceiving and receiving antennas 4 and 5 (Fig.69) are installed on the aircraft fin . Radio set PCMV-3M employs concealed surface antennas made of brass gauze No.0.15 State Standard POCT 3584-53. They are shaped as triangles and glued to the fin tail cone made of aircraft plywood.

Buttons TK-4M on the control column (intercom system) are intended to engage the throat microphones and to connect the "ground" to relay PH-2 engaging the transmitter of PCMV-3M. The relay is set in the upper (overhead) electric panel of the pilots.

Power supply, protection and wiring of the set. The radio set receives direct current from the duplicate supply busbar of the operator's circuit breaker panel through circuit breaker A3C-5.

The A.C. supply is fed from the operator's fusible cut-out panel through fuzible cutout CH-2.

The R.F. cables from the antennas to the transmitter and receiver No.2 are laid in a conduit along the rear spar of the fin. Upon leaving the conduit, the cables are attached with the aid of clips and sleeves. The cables are laid through the airtight wall of the cabin in special airtight inputs. Bunched wires and cables connecting the transmitter,

receivers and rectifier, are laid along the front shaped member of the upper support and are fixed by means of metal clips with rubber padding. The wires running from the receivers and transmitter to the control panels are laid along the aircraft starboard side together with the electric wires.

4. AIRCRAFT INTERCOM CMJ-10

The aircraft intercom system CMJ-10 (Fig.70) is intended for communication between the members of the crew, for external communication done with the aid of the communication and command radio sets, and for receiving signals via the ARK-5 radio compasses No.1 and No.2.

The aircraft intercom system comprises:

	No.req'd
- amplifier	2
- one-cord intercom set (without additional panel)	3
- two-cord intercomm set (with additional panel)	3
- additional panel	3
- dynamotor V-19 with filter	2
- supply line filter	2
- four-contact button TK-4M	13
- two-contact button 2TK	2
- distribution box	8
- headset	6 (not furnished with the aircraft)
- extension cable, 1.4 m. long	6
- extension cable for work in rear cabin 2-4, 10 m. long	1

The intercom system CMJ-10 may be fed with A.C. and D.C. and has amplifier, dynamotor and supply-line filter for each line.

Technical Data

Rated voltage of D.C. source (aircraft mains)	25 V
Throat microphone feed voltage	4 - 5 V
Operating current consumed by one dynamotor with amplifier	not exceeding 1.3 A
Operating current consumed by one intercom set with one relay engaged	not exceeding 0.12 A
Average voltage while speaking over 14 pairs of telephones connected in parallel to the amplifier output, with two pairs of throat microphones Ja-5 connected to its input	not less than 50 V
Change of output voltage with the number of engaged telephones Ta-4 reduced from 14 pairs to 1 pair	not exceeding 15%
Amplification factor	about 200
Automatic improvement of amplification:	
at altitudes of 5 to 6 km.	about 1.8 times
at altitudes of 7 to 8 km.	about 2.5 times
Reduction of output voltage upon connecting the second pair of throat microphones Ja-5	not exceeding 25%.
Frequency characteristics of the amplifier have smooth rise by 15^{+3} decibels	from 30 c.p.s. to a range of 2500 to 3500 c.p.s.
Non-linear distortion factor under 50 V, at 1000 c.p.s.	not exceeding 5%

The plate circuits of the amplifier are fed from the dynamotor with the filters in the high and low-voltage circuits.

All intercom sets are connected in parallel, therefore the conversation of two members of the crew can be heard by all members who set the switches of their intercom sets for internal communication.

Weak signals of throat microphones are amplified by means of special amplifiers so that 14 sets can operate.

The intercom includes: intercom set proper, additional panel (furnished only for the pilots and navigator), four-contact button and additional two-contact button (for the pilots only), headset with a pair of throat microphones Ja-5 and telephones Ta-4.

Amplifiers Nos 1 and 2 of intercom system circuits are four-stage amplifiers of low frequency employing three twin triodes 6N8C. The amplifiers provide an automatic increase of the amplification capacity at two stages with the aid of a pressure relay 1.8 times at altitudes between 5000 to 6000-m., and 2.5 times at 7000 to 8000-m.

Amplifier No.2 is intended for circuit No.2, its power being sufficient for all consumers. Amplifier No.2 (Item 12 in Fig.65) is installed at the bottom of frame No.2 on the operator's panel support.

Amplifier No.1 receives voltage from the duplicate bus-bar and from the storage battery, i.e. circuit No.1 is fed even if the mains are de-energized because of some damage.

Amplifier 41 (Fig.71) of intercom circuit No.1 is installed on the port-side equipment support between frames Nos 11 and 12.

The amplifiers are installed on four rubber shock absorbers each. They can be quickly released as the shock mount secured to the support shaped members is provided with two latches that are taken apart to remove the amplifier.

Intercom set. The intercom sets are intended for interior communication of the aircraft crew members with the aid of intercom system amplifier and for external communication carried out with the aid of the radio equipment.

Intercom sets are used for switching the throat microphones and headset telephones for various types of communication.

The intercom set ensures two-way communication through both circuits of internal communication and three radio sets; it is also intended for conference call by voice.

The vital portion of the intercom set is a multiple-contact mode-of-operation selector of wafer type designed for bringing the telephones and throat microphones to five positions.

The intercom sets intended for operation with an additional panel (two-cord) do not basically differ from the one-cord sets, but in addition to the four-core cable with connector for engaging the headset they are also provided with five core shielded cables with connector to be joined to the additional panel.

For cutting in the supply circuits of the throat microphones and for remotely switching the required relay (starting relays of the transmitters), the crew members must press four-contact buttons TK-4M to be handled by hand or foot. The design of the foot button switch is shown in Fig.72.

Table 12 deals with the arrangement of the intercom sets with the buttons for connecting the throat microphones.

Figures 63, 66 and 71 show the arrangement of the intercom sets, buttons of auxiliary panels, filters, dynamotors, amplifiers and connector boxes of the intercom system CHY-10.

Dynamotor Y-18 is provided with M-shaped high voltage filters accommodated in common box for smoothing the ripple and for decrease of the noise during the operation of the amplifier.

Every member of the crew can operate the mode-of-operation selector on the intercom set to cut in the telephones

and throat microphones of his headset for internal communication (refer to Table 11). Besides, the navigator, pilot and co-pilot can establish external communication operating the communication radio set 1PCB-70, command radio set 1-PCB-70M, command radio set PCMY-3M; they can also monitor the operation of automatic radio compasses APK-5 No.1 and No.2 using additional panel;

- the navigator-radar-operator can establish external communication employing communication set 1-PCB-70, command radio set 1-PCB-70M, and command radio set PCMY-3M;

- radio-and-cannon-operator can establish external communication employing the communication set 1-PCB-70 both for telephone and telegraph versions, employing command radio set 1-PCB-70M (for the telegraph version only) and radio set PCMY-3M (for the telephone version only);

- gunner can establish external communication employing the ultrashort-wave command set PCMY-3M.

These are the only application versions of the intercom system CHY-10 on the airplane Ty-16.

The intercom set telephones are connected directly to the circuit, while engagement of the throat microphones requires that one of the four remote-control four-contact buttons (hand-operated or foot-pressed) should be pushed. The location of the buttons is shown in the table.

Through the button fed are the throat microphones and dynamotor starting relay of the radio set where the wafer switch for five positions is installed.

Table 12

Location of Intercom Sets and Buttons

Crew member	Location		
	intercom set	additional panel	throat microphone cut-in button
1	2	3	4
1. Navigator	Right portion of operating panel	Next to intercom set	Foot button switch located on the floor next to frame No.1, left side; a button on cource stabilizer; a button on left console
2. Pilot	Port side, between frames 6 and 7	Do	Internal and external communication buttons located on the control column wheel, right horn; button and lever on the autopilot formation stick
3. Co-pilot	Starboard, between frames 6 and 7	Do	Internal and external communication buttons located on control column wheel, left horn
4. Navigator-radar operator	Upper part of fuselage, on operator's panel support	Do	Button on operator's instrument panel; foot button switch on foundation; button on sighting station
5. Radio-gunner	Port side, between frames 72 and 73	Do	Two buttons on sighting stations; button switch under right foot

1	2	3	4
6. Gunner	Starboard, between frames 73 and 74	Next to intercom set	Button on sighting station; button switch under right foot

When the selector is set to "СПУ", the telephones connect to the amplifier output of circuit No.1 or circuit No.2, depending upon the position of the circuit selector (located left of the mode-of-operation selector on the intercom set). This circuit selector is also used for changing over the circuits.

For convenience in carrying out the internal communication, all intercom sets mount conference call buttons labelled "ЦЕПК.ВЫЗ." If necessary, every crew member can call upon other members by voice irrespective of the circuit it forms part of. There is no need in this event to press the four-contact button.

Having told what he wanted to, the user releases conference call button, and all the other users come back to the communication mode they employed before the call was sounded.

The crew members called upon should set the selectors of their intercom sets to СПУ and carry out communication using one of the internal communication circuits specified by the calling customer.

The intercom system СПУ-10 ensures for the pilots a quick change from the external communication to the internal communication irrespective of the position of the mode-of-operation selector on their intercom sets.

For this purpose, two-contact buttons of the 204K type labelled "СПУ" are located on the control column wheel horns next to four-contact buttons ТК-4П. The СПУ buttons provide change-over to internal communication irrespective of the position of the mode-of-operation selector (relay incide

the intercom set functions). The communication is carried out through the circuit to which the circuit selector is brought. During the conversation the button is kept pressed. Releasing the СПУ button, the pilot comes back to the kind of communication he had used before the button was pressed.

One need not press the four-contact button when using the two-contact one.

Cast handles on the steering wheels with buttons ТК-4М and 204К are provided with inscriptions RADIO SETS (РАЦИИ) and СПУ engraved on them (respectively).

The pilot operating the formation stick of the autopilot АП-5-2М can govern the lever provided in the upper foreward portion of the handle for closing the throat microphone circuit and for starting the dynamotor of any radio set.

There are airplanes where the pilot's switching diagram differs from the one described above. The difference is as follows:

(1) relays inside the intercom sets are not installed and the switching is accomplished with the aid of relays РП-6 and РП-2 installed inside the relay boxes;

(2) connection of four-contact button (marked СПУ) and of two-contact button (marked СПУ при УКВ) differs from the one described here:

(a) button СПУ or СПУ при УКВ may be pressed on the control wheel for carrying out internal communication with the mode-of-operation selector set to СПУ;

(b) when the mode-of-operation selector is set to COMMAND RADIO SET (КОМ.РС) or communication RADIO SET (СВЯ.РС) the external communication is established (power supply fed to the throat microphones and transmitter starting relays) by pressing any of the buttons in question (СПУ or СПУ при УКВ);

(c) for changing over from external to internal communication, with the mode-of-operation selector set to ULTRA-SHORT-WAVE RADIO SET (УКВ РС), СПУ при УКВ button should be pressed;

(d) the external communication can be changed over to the internal communication only when the mode-of-operation selector is set to УКВ.

Switch No.1 of intercom system СПУ-10 is mounted on the overhead electric panel of the pilots, circuit breaker АЗС-5 on the circuit breaker panel of the co-pilot. The dynamotor and amplifier of circuit No.2 are supplied through circuit breaker АЗС-5 from the normal mains via the radar-operator's circuit breaker panel. Switch П-45 of circuit No.2 is located on the pilots' overhead electric panel.

The wiring of the intercom system СПУ-10 is laid together with electric cables, wires, types БПВЛЭ and БПВЛ light blue colour, being used for the purpose. The wires of the aircraft intercom system are laid as far from the A.C. cables as possible.

5. EMERGENCY RADIO SET АВРА-45

Emergency radio set АВРА-45 (Fig.73) is intended for sending distress signals or bearing data in case of forced landing.

The radio set assembly includes:

(1) transmitter;
(2) trailing antenna;
(3) unit rotation crank;
(4) kite;
(5) two generators for filling the balloons with hydrogen;
(6) two rubber balloons for raising the antenna;
(7) signalling lamp;
(8) parachute;
(9) soft packing;
(10) counterweight.

The radio set АВРА-45 with the parachute is installed in the pressurized cabin on the starboard side between frames 9 and 10 above the modulating unit of radar bomb sight РБП-4.

The emergency radio set ABPA-45 can be engaged for transmission at fixed frequency of 500 Kc.p.s. only. The antenna power of the transmitter is 5 W. The transmitter is fed from the generator mounted inside the transmitter housing. The generator is rotated by hand. Depending on the position of the mode-of-operation selector, the radio set can automatically send out distress signals S.S, or bearing signals AA. Besides, the button type telegraph key can be used for sending telegraphic radio signals or light signals from the lamps. The radio set housing is made watertight and can float when dropped into water.

Section II

RADIO NAVIGATION EQUIPMENT

The radio navigation equipment installed in the aircraft is provided for determining the coordinates, for in-bound and outbound flight, taking bearings of the housing stations, determination of the true altitude of flight, determination of the distance to the airfield, carrying out the flight in the holding zone, ILS approach and landing. As these missions require, aircraft TU-16 mounts the following radio navigation equipment: radio compasses APK-5 No.1 and No.2, altimeters RV-17M and RV-2, radar ranging unit SD-1[x]; marker receiver MRP-48P, course equipment KRP-2, and glide-path equipment GRP-2.

The lay out of the radio navigation equipment in the airplane is shown in Figs 74 and 75.

1. RADIO COMPASS APK-5(No.1 and No.2)

Designation and Set

The APK-5 automatic radio compasses are designed for navigating the airplane by homing and broadcasting radio

x/ To be also referred to as D.M.E. (distance measuring equipment).

stations and radio beacons, for determining the estimated position of the airplane, the approach and landing with the aid of the instrument landing system.

The automatic radio compass is designed for solving the following navigation problems:

(a) inbound flight with the visual indication of course;
(b) inbound flight with aural indication of course;
(c) outbound flight (auxiliary facilities);
(d) determination of drift angles and wind vector;
(e) automatic determination of the radio station bearings by the radio compass indicator and also aurally;
(f) flight by the radio beacon sending the modulated pulses and operating for bearing and zone versions.

Mounted on the airplane are two radio compasses APK-5 No.1 and No.2. As there are two compasses, there is no need to re-tune the radio compass when determining the location of the airplane on the basis of the bearing values provided by two radio beacons. Besides, automatic radio compass APK-5 No.2 is a spare one to be used when radio compass No.1 gets out of order.

Radio Compass APK-5 No.1

The set of automatic APK-5 No.1 (Fig.104) includes:

(1) pick-up unit;
(2) inboard loop;
(3) navigator's control panel;
(4) pilot's control panel;
(5) navigator's two-pointer indicator (UPU-1);
(6) pilot's indicator (UKUP-1);
(7) relay box;
(8) silica gel cell;
(9) flexible shaft two-piece;
(10) rod antenna.

Characteristics

The continuous band of the radio compass ranging from 150 to 1300 Kc.p.s. (2000 to 230 m.) comes in three subbands:

- 150 to 310 Kc.p.s.;
- 310 to 640 Kc.p.s.;
- 64[illegible] to 13[illegible] Kc.p.s.

Errors to be tolerated:

(a) not exceeding $\pm 3^{\circ}$ for bearing irrespective of frequency;

(b) not exceeding 2.5% at any point within the band for calibration with 2-m. length of flexible shaft. The margin along the scale ends should be at least 1% of the extreme specific values of every subband.

The oscillations of the indicator pointers must not exceed 5°, and the loop must invariably come back to the original position with an accuracy of $\pm 3^{\circ}$ at minimum.

If radio compasses No.1 and No.2 are tuned to the same radio station, the permissible mismatching should not exceed 6° ($\pm 3^{\circ}$ for each compass).

Sensitivity of the pick-up unit is 1[illegible] to 12 μV, and the extreme sensitivity for housing is 5[illegible] μV/m.

The operating range of the radio compass at 1[illegible]-m. altitude is 18[illegible] km., and at 5[illegible]-m. altitude, 24[illegible] km. when operating with housing radars of the NAP-3B type. The compass is fed from the 28.5 V, D.C. mains and from 115 V, 400 c.p.s., A.C. mains of the aircraft.

Except the inboard loop, radio compass APK-5 No.1 is located in the front pressurized cabin.

The radio compass is operated by the navigator and the pilot. The navigator tunes the radio to the specific frequencies, determines the location of the aircraft by taking bearing of two ground stations, and solves other navigation problems.

The receiver is tuned from the remote control panels of the navigator and the pilot with the aid of flexible shafts. The pilot can flight his airplane according to the

readings of his indicator. The co-pilot can tune the compass to homing stations without changing his position (from the pilots' control panel) and navigate the airplane consulting his indicator.

Principle of Operation

The automatic radio compass has two antennas, one being directional (loop), and the other non-directional or open. The electromotive force taken over by the loop is amplified by the loop channel amplifier to be fed to the phase commutator.

Besides the R.F. pulse the phase commutator receives L.F. voltage (about 5[illegible] c.p.s.) from the tone generator. The electromotive force generated by the phase commutator reaches the antenna circuit of the receiver. The receiver antenna circuit also receives the R.F. pulse taken over by the non-directional antenna.

The electromotive force obtained as a result of interaction of the loop pulse (via the phase commutator) and the antenna signal is amplified by the receiver, rectified, amplified by the low frequency circuit and then delivered to the control circuit of the radio compass. The control circuit generates voltage actuating the motor and the loop connected to it to rotate until the longitudinal axis of symmetry of the loop gets aligned with the direction to the radio station. In this instance, the electromotive force induced in the loop will be equal to nil, and the voltage, making the motor rotate will be also nil.

The rotation of the loop is imparted to the axle of the transmitting selsyn through the gear train. The indicating selsyns follow the rotation of the transmitting selsyn axle and show the angle between the aircraft fore-and-aft axis and the direction to the radio station.

There is provision for manual rotation of the loop - by means of the switch РАМКА Л-П (LOOP L-R) when the mode-of-operation selector is set to LOOP (РАМКА).

When the compass is engaged for operation, joint functioning of the loop channels and non-directional antenna is ensured.

When operating for the antenna only, the radio compass functions as an ordinary superheterodyne receiver, and when for the loop only, as aural direction finder.

Units of Radio Compass APK-5 No.1

Receiver APK-5 employs a superheterodyne circuit with 15 tubes. The compass portion is provided with loop rotation automatic control set at its output.

The receiver is mounted behind the pilot's seat on the equipment rack between frames Nos 9 and 10. The receiver is secured to the rack with five bolts locked to the shock mount having four shock absorbers.

Loop. The inboard loop is adjusted for upper location. The loop antenna unit includes the loop proper, loop rotation electric motor, and the radio deviation compensator.

The loop has a magneto-dielectric core with a winding. The winding ends are passed through three commutator rings attached to the loop axle and taken as far as the peg of the cable connecting the loop with the receiver.

The loop of automatic radio compass APK-5 No.1 is placed on the shock mounts in the upper portion of the non-pressurized compartment next to frame No.13.

The slot between the loop and the body at the dielectric disc is screened with flexible gauze No.004, State Standard 6613-53.

Navigator's control panel is located over the navigator's table, next to frame No.3, port side. The panel ensures complete remote control of the automatic radio compass. All controls are mounted on the front board of the panel.

The pilot's control panel is similar to the navigator's panel. It is installed on the pilot's hydraulic control panel between frames Nos 6 and 7.

The УШДБ-1 two-pointer course indicator of the navigator is a receiving mag-slip with the needles of radio compasses No.1 and No.2 fixed to the two axles of the mag-slip rotors. It is electrically connected to the loops of radio compasses No.1 and No.2 which is respectively marked on the pointer. The indicator is installed on the instrument panel of the navigator. The errors of the mag-slip indications should not exceed: $\pm 0.5^{\circ}$ on the zero mark and $\pm 1.5^{\circ}$ on other marks for the short-shafted pointer (pointer No.1 of indicators УШДБ-1 and БСУП-1; $\pm 1.5^{\circ}$ on the zero mark and $\pm 2.5^{\circ}$ on other marks for the long-shafted pointer (pointer No.2 of indicator УШДБ-1).

Pilot's mag-slip pointer indicator БСУП-1 is mounted on the pilot's instrument panel.

Relay box (distribution box) of automatic radio compass serves for switching the receiver over from one control panel to the other. The box is located above the receiver of automatic radio compass No.1 between frames Nos 9 and 10. It is attached to two vertical shaped members of the panel support.

Silica gel cell made of plexiglass is set in the clamps near the frame to which it is connected by means of a rubberized hose.

The receiver is tuned from two control panels with the aid of a tee-piece located on the left rear bracket of the vertical flight gyro of the autopilot АП-5-2М, and with the aid of flexible shafts.

Antenna feed-in No.1 is made of wire ПВЛ, cross section 1.3 sq.mm.

The wire is secured by means of two insulators made of ebonite or organic glass. Near the receivers, the wire is separated from the feed-in of automatic radio compass APK-5 No.2 by means of an organic glass strip.

Radio compass APK-5 No.1 receives D.C. from the navigator's circuit breaker panel via circuit breaker АЗС-2 and 115 ± 3 V, 400 c.p.s. A.C. from the navigator's fuzible link panel via fuzible link СП-5. Every control panel has its own protection means for the automatic radio compass APK-5.

These are: 2 A fuzible link for A.C. supply and 5 A fuzible link for D.C.

Automatic Radio Compass APK-5 No.2

The set of automatic radio compass No.2 (Fig.77) includes:

(1) receiver;
(2) inboard loop;
(3) control panel;
(4) pilot's course indicator;
(5) silica gel cell;
(6) blister surface antenna.

The navigator takes the readings of radio compass No.2 by two-pointer course indicator УКДБ-1. All components of automatic radio compass No.2 (except for the loop), are mounted in the front pressurized cabin (Fig.71).

The principle of operation of the radio compass and the design of its units are similar to those of compass No.1.

Receiver of automatic radio compass No.2 is located on the support behind the pilot's seat between frames Nos 9 and 10 so that it stands under receiver of compass No.1. Receiver of compass No.2 is locked in the same manner as the receiver of compass No.1.

Loop antenna is located in the lower portion of the fuselage between frames 12 and 13.

Pilot's course indicator is located on the co-pilot's instrument panel.

Antenna 3 (Fig.77) of automatic radio compass No.2 is glued up to the inner surface of the radar-operator's blister.

Antenna feed-in made of 1.3 sq.mm wire ПВЛ is connected to the antenna block and laid upon ebonite base insulators.

The outer circuit being unprotected, the D.C. supply is delivered to the automatic radio compass from the navigator's circuit breaker panel, and the A.C. supply of 115 V, 400 c.p.s. from the navigator's fuzible link panel.

2. RADIO ALTIMETERS PB-2 AND PB-17M

Low-altitude radio altimeter PB-2 and high altitude radio altimeter PB-17M are provided for determining the tune altitude of flight. Both radio altimeters employ the principle of time variation as the radio waves travel from the aircraft to the earth and back to the aircraft. The radio altimeters differ in the type of wave radiation, the PB-2 emitting continuous waves and the PB-17M sending out pulses. For the layout of the instruments and components of the radio altimeters refer to Fig.78.

Low-Altitude Radio Altimeter PB-2

Low-altitude radio altimeter PB-2 is intended for determining the true altitude of flight.

The functioning of the altimeter does not depend upon the weather conditions, cover of ground, and speed of flight.

Performance Data

Altitude range	0 to 1200 m.
first range	0 to 120 m.
second range	100 to 1200 m.
Altitude indication lag for aircraft Ty-16	12.5 m.
Altitude measurement precision over first range	±2 m. ±5% of the altitude measured
Transmitter mean frequency	Fm = 444 ±2 Mc.p.s.
Frequency wobbling band:	
in first range	37 ±4 Mc.p.s.
in second range	4 Mc.p.s.
Modulation frequency	124 ±3 Mc.p.s.
Power emitted	not less than 0.15 W

Power consumed ..... not exceeding 70 W
Sensitivity:
first range ..... not less than 80 db (46 conventional units)
second range ..... not less than 70 db (36 conventional units)

The set of PB-2 (Fig.78) includes:
(1) transceiver;
(2) supply dynamotor of PB-2;
(3) indicator IPB-46
(4) audio frequency filter Q34-1B.

The PB-9 and PB-17M altimeters have common antennas included in the set of the PB-17M.

Principle of Operation

Low-altitude radio altimeter PB-2 operates on the princi of reflecting from the ground the radio waves emitted by the altimeters transmitter as R.F. oscillations modulated in frequency. The reflected pulse gets as far as the receiver input where the direct pulse of the transmitter is taken. The reflected pulse comes with a time lag, so the frequency of the reflected pulse differs from the frequency of the direct one at a given moment.

The difference of these frequencies measured by the altimeter and converted into D.C. is supplied to the altimeter indicator graduated in metres.

Altimetor Units

The shock mount of the transceiver is installed on the equipment support at the bottom part of frame No.22.

Dynamotor PV-11A with the filter box is located on the upper rack of the support above the transceiver of radio altimeter PB-2. It is provided for supplying high voltage

D.C. to the tube plates. The dynamotor is a two-pole one-armature converter.

The dynamotor base is provided with four rubber shock absorbers.

The radio-altimeter PB-2 is fed from the D.C. busb r through circuit breaker A3C-5 mounted on the pilot's circuit breaker panel. Audio frequency Q34-1B is located above the transceiver of radio altimeter PB-2 next to the dynamotor PV-11A. It serves for suppressing the noises generated by the cable supplying power from the aircraft mains to the socket.

The R.F. wiring running from the antenna switch AN-1 to the transceiver is secured with the aid of rubber-padded clamps fitted to the support by bushings. The feed cable running to the dynamotor is shielded and attached to the support with the aid of the clamps with bonding padding. The feed cable of the dynamotor running from the aircraft mains is connected through audio frequency filter Q34-1B to the socket of radio altimeter PB-2 installed on frame No.22.

High Altitude Radio Altimeter PB-17M

Radio altimeter PB-17M is intended for measuring the true altitude of the aircraft above the ground within 100 to 17000 metres irrespective of the weather and visibility conditions.

The set of the PB-17M (Fig.78) consists of the following:
(1) transceiver;
(2) indicator;
(3) two antennas (receiving and transmitting);
(4) antenna switch AN-1.

Performance Data

The altitude is measured employing the pulse method, the accuracy of readings on scale 0-1 being 10 m.

The accuracy of scanning dial of "X1" scale equals ±15 m. ±0.25% of the altitude measured; and of the dial having "X10" scales, 150 m. ±0.25% of the altitude measured. The carrier frequency of the transmitter is 440 ±1 m.c.s.

The average power of the transmitter of the dial of "X1" scale is not less than 0.2 W, the duration of the pulse radiation amounting to approximately 0.5 μ sec. The indicator scale is graduated within 0 to 1000 metres.

Principle of Operation

The operation of the radio altimeter is based on the pulse principle: the radio altimeter transmitter emits R.F. pulses which propagate toward the earth to be reflected and returned back to the airplane where they are taken by the receiving antenna. The reflected pulses amplified by the receiver are sent to the indicator. Besides the reflected pulses, the receiver input takes up the direct (main) pulses which are directed to the indicator from the receiver output. The indicator measures the time lapsed between the moment of the pulse radiation and the moment of its return which is proportionate to the altitude of flight. The readings are taken off the leading edges (left side) of the direct and reflected pulses obtained on the indicator scale graduated in metres.

The display tube scale is graduated from 80 m. to 17000 m.

The indicator screen displays circular scan with two marks (pulses), one keeping to zero while the other depending on the altitude travels to indicate the altitude.

The indicator of radio altimeter PB-17M is mounted on the left console of the navigator between frames 4 and 5.

The transceiver of radio altimeter PB-17M is located on the support under the transceiver of radio altimeter PB-2 next to frame 22. The shock mount of the transceiver is attached to the second rack of the panel support.

The receiving and transmitting antennas are nothing more than a symmetric oscillator. The antennas are arranged under the airframe on the access doors as though forming continuation of each other, the receiving antenna being set between frames 23 and 24, and the transmitting antenna, next to frame 30.

The antennas are intended for both altimeters. The switch AP-1 mounted on the lower side of the panel support rack under the transceiver of radio altimeter PB-17M is intended for changing the receiving and transmitting antennas over from one radio altimeter to the other. The switch AP-1 functions automatically, i.e. the antennas get disconnected from the radio altimeter PB-17M upon engagement of the radio altimeter PB-2, though the circuit of the PB-17M remains energized if the current has been applied to it before. If the pilot switches off radio altimeter PB-2, switch AP-1 again connects the antennas to radio altimeter PB-17M. The switch AP-1 is controlled through relay PP-2 set in the fuel gauge distribution box by means of switch installed in the left lower angle of the indicator PB-2 located on the pilot's instrument panel.

Power supply to the radio altimeter PB-17M is taken from the 115 ±3 V, 400 c.p.s. A.C. busbar through fusible link CP-5 on the navigator's fusible link panel and through fusible link CP-2 on indicator front panel.

The antenna switch AP-1 is fed with current from the pilot's circuit breaker panel through circuit breaker A3C-2.

The R.F. cables from the receiving antenna up to the antenna switch are passed along the pipe under the plating of the second fuel tank access door made of vitrified textolite (access door for the antenna and the pipe being required for replacement of the R.F. cables) and along the bottom part of frame 22 where it is secured by means of rubber-padded clamps; from the transmitting antenna at frame No.30, the R.F. cable pass over to the port side, runs along stringer 15 to reach frame 22; passing along stringer 15 bottom the cable comes to switch AP-1.

Radio frequency cable running from the transceiver to the indicator is laid along the bottom piece of frame 22 up to stringer 4 and farther along the stringer as far as the sealed gland on the bottom piece of frame No.12 (next to stringer 7).

Beginning with frame 12, the cable is laid together with the bunched conductors of the electric system along the port side up to the indicator of altimeter PB-17M.

3. INSTRUMENT LANDING SYSTEM СП-50

The radio equipment of the instrument landing system carried aboard the aircraft is intended for determining the distance to the D.M.E. transponder-beacon, for navigating the airplane in the hold zone along circular orbits, determining the true distance to the landing point, borders of the air-field, and for blind landing of the aircraft. The equipment of the instrument landing aids is divided in three autonomous parts: distance measuring (D.M.E.) equipment СД-1, marker receiver set, and "blind landing" instruments.

Depending on the problems confronting the crew, all the equipment or only certain units of the system may be employed. Diagram of instrument landing equipment СП-50 carried aboard the airplane is shown in Fig.75.

Distance Measuring Equipment СД-1

The aircraft distance measuring equipment serves for:

(a) determining the distance to the air-field of landing or to any other airfield provided with D.M.E. transponder of the РД-1 type;

(b) navigating the airplane along the circular orbits around the landing airfield;

(c) indicating the distance to the landing point on the landing run.

Besides, the distance measuring equipment facilitates and ensures the calculation of the speed of approach to the air-field, calculation of the time needed to approach to the airfield, and so on.

The D.M.E. (Fig.79) includes:

(1) receiver;

(2) transmitter;

(3) indicator ИРД-50

(4) control panel;

(5) receiving and transmitting antennas.

The СД-1 mounted in the aircraft is characterized by the following performance data:

1. Two modes of operation:

(a) measuring of the distance or indication of the distance from the aircraft to the airfield with D.M.E. transponder РД-1;

(b) orbiting, i.e. indication of circular orbits to be flown around the airfield equipped with РД-1.

2. The D.M.E. СД-1 shows the range to the circumference with the D.M.E. transponder РД-1 located in its centre (the circumference running through the beginning of the runway).

The coverage of the distance measuring equipment СД-1 (i.e. the maximum range to the airfield that might be measured by the equipment) depends upon the altitude of flight. At an altitude of 5000-m. the coverage is 150-km.; the altitude getting lower, the coverage decreases. At an altitude of 1000 m. it is equal to 80 - 90 km.

Measurement ranges:

- first range: 0 to 30 km.;
- second range: 10 to 150 km.; the ranges are marked on appropriate scales of indicator ИРД-50.

3. Accuracy of measurement:

(a) when operating within the first range the error is not over 600 m. ±2% of the distance measured;

(b) when operating within the second range the error does not exceed 3000 ±2% of the distance measured under normal weather conditions.

4. With the aid of distance measuring equipment the aircraft can be directed around the airfield along six orbits (9, 11, 13, 15, 17 and 19 km. from zero circumference) until the airfield is ready to receive the airplane. The airplane is in this instance navigated with the aid of pointer-type zero indicator.

The precision of the orbit indication is at least ±250 m. under normal weather conditions and at least ±450 m. under adverse weather conditions.

5. The distance measuring equipment employs three channels of communication (by coding the paired pulses).

6. Any of the simultaneously functioning D.M.E. transponders РД-1 can be chosen by means of the COMMUNICATION CHANNELS (КАНАЛИ СВЯЗИ) knob.

The call signals of the D.M.E. transponders are indicated by a neon lamp that lights up simultaneously with the signals being sent (Morse code).

7. Operating frequencies: 845 Mc.p.s. (35.5 cm.) for the transmitter, and 895 M/cs (33.4 cm.) for the receiver.

8. Power consumed from the aircraft mains is not more than 720 W.

The distance measuring equipment is operated by the pilot having indicator ПРД-5С and control panel within his reach. The receiver of the distance measuring equipment is installed on the starboard side in the compartment accommodating colour flare bombs. The equipment receiving antenna is located ahead of the colour flare bomb compartment. The transmitter and transmitting antenna of the distance measuring equipment are installed in the rear compartment Ф4.

The measurement of distance from the aircraft to the airfield D.M.E. transponder is based upon measuring the time of the pulse signals passing from the aircraft to the airfield D.M.E. transponder and back.

The transmitter of the aircraft distance measuring equipment emits paired pulses following at 100 c.p.s. frequency (time shift between pulses being 10000 microseconds).

Those interrogation paired pulses are received by the antenna of the D.M.E. transponder receiver. The decoder located in the receiver of the D.M.E. transponder is intended to decode the pulses (to pass the paired pulses only of the channel the decoder is tuned to) and convert them into single pulses. The single pulses modulate the transmitter of the D.M.E. transponder which radiates the response pulses through the transmitting antenna.

The response pulses of the D.M.E. transponder are taken by the receiving antenna of the D.M.E. СД-1, amplified in the receiver at intermediate and low frequencies, and directed to the input of the selector and measuring circuits of the distance measuring equipment. The starting pulses of the aircraft distance measuring equipment coming to the input of the selector circuits and the response pulses of D.M.E. transponder РД-1 are separated by a time delay. The distance to the D.M.E. transponder is determined by this time delay.

The airfield D.M.E. transponder responds to many (up to 45) aircraft D.M.E. systems, and the input of its receiver takes the response pulses of all systems СД-1. For selecting the required response pulses, the receiver of distance measuring equipment СД-1 is provided with time selector whose pulses unlock the receiver shortly before the response pulses come. As the aircraft approaches the airfield, the time to unlock the receiver is automatically changed. The transmitting frequency (845 M/c.s.) differs from the receiving frequency (895 M/c.s.) so that the transmission does not interfere with the reception.

The measuring circuit of the aircraft D.M.E. generates voltages proportionate to the delay and puts into action the range indicator (a D.C. instrument graduated in kilometres).

The orbit flying is ensured by special tuning of the D.M.E. measuring circuit.

The deviation of the pointer of indicator ПРД-5С depends upon the direction of flight along the circumference (orbit)

and the direction of the airplane deviation from the orbit:

- if during left circle flying the pointer of instrument ПРД-50 shows to the left of the centre of the orbit scale triangle mark , the orbit lies on the left and the aircraft should be turned also to the left, and vice versa;

- if during right circle the pointer of instrument ПРД-5. shows to the left of the centre of the orbit scale triangle mark , orbit lies to the right and the aircraft should be turned also to the right, and vice versa.

All controls of the D.M.E. are concentrated on the control panel (Figs 71, 79) and on the range indicator mounted on the pilot's instrument panel.

The transmitter of aircraft D.M.E. is combined with the supply unit. It serves for creating the R.F. paired pulses of interrogation emitted by the transmitting antenna.

The transmitter is installed in the rear compartment 04 on the rack between frames Nos 57 and 58 so that its base is at the level of stringer No.10.

The shock mount with four shock absorbers serves for securing the transmitter to the rack by means of six screws, 5-mm dia. and a nut.

The transmitter is easy to remove: its body is attached to the shock mount with the aid of two hinge-joint screws with a shaped non-falling nut. The front panel of the transmitter carries three plug connectors (one of them being R.F. for the transmitting antenna) marked TRANSMITTING ANTENNA (АНТЕННА ПЕРЕДАЮЩАЯ), SUPPLY (ПИТАНИЕ), and RECEIVER (ПРИЕМНИК). On the front panel, between the plug connectors the axle of potentiometer is projecting for the purpose of the voltage (115 V, 400 c.p.s.). Besides, there are two fusible links and two handles on the panel (the handles serve for removing and installing the transmitter).

The exterior appearance of the D.M.E. receiver is similar to the D.M.E. transmitter.

The receiver of the aircraft D.M.E. serves for reception and amplification of pulses sent out by the airfield D.M.E. transponder and for creating the voltage proportionate to the transponder.

The receiver is mounted on the starboard side, on the rack between frames 51 and 52 (the base standing at the level of stringer No.13).

The receiver is attached to the bracket by means of eight bolts, 5-mm dia., and anchor nuts.

On the front panel of the receiver there are three receptacles: TRANSMITTER (ПЕРЕДАТЧИК), CONTROL PANEL (ЩИТОК) and RECEIVER ANTENNA (АНТЕННА ПРИЕМНИКА).

The remote control panel is mounted on the port side on the common board with panel M-50 of ILS control between frames 6 and 7 (Fig.71). It serves for operating the D.M.E.; its knob marked D.M.E. (ДАЛЬНОМЕР) is intended for changing over the channels, and the knob marked ORBITS (ОРБИТЫ) for selecting one of six orbits. The aircraft D.M.E. is switched on from this panel.

The quick-release panel is attached to the base by means of latches. The panel base is connected to the board with the aid of four screws, 5-mm dia.

Range indicator ПРД-50 is a pointer-type electromagnetic instrument for measuring distance. It mounts knobs for changing the modes of operation and selection of the specific distance band. The indicator is located on the pilot's instrument panel.

The transmitting and receiving antennas of the D.M.E. are identically made half-wave shortened vertical rods.

The transmitting antenna is intended for radiating the interrogation pulses and is located in the lower portion of the airframe along the aircraft axis between frames 56 and 57. The antenna is reached through special access doors.

The receiving antenna is used for receiving the response pulses sent by the D.M.E. transponder. It is installed

in line with the transmitting antenna between frames 49 and 50 (along the aircraft axis).

Power supply. The D.C. is supplied to the distribution box of the D.M.E. (mounted in the rear compartment 24 between frames 58 and 59) from the left circuit breaker panel of the navigator through circuit breaker A3C-2, and the 115 V A.C. is taken to the D.M.E. distribution box from the navigator's fusible link panel through fusible link CП-5.

Wiring. The R.F. cables from the receiving and transmitting antennas to the receiver and transmitter are fixed to the stringers with the aid of latch (transmitter cable), to the bottom part of frame No.49 (receiver cable) with the aid of screws and self-locking nut, and along the line of electric cables between frames 49 and 51, by means of clamps.

Marker Receiver МРП-48П

The marker receiver МРП-48П (Fig.75) is intended for receiving the pulses of the airfield marker transmitters (radio beacons МРМ-48).

The marker receiver employs a signalling bell and warning lamps to determine the moment when the airplane flies over the marker radio beacon МРМ-48 while doing the landing approach and gliding.

The set of marker receiver МРП-48П (Fig.80) includes:

(1) marker receiver;
(2) inboard antenna;
(3) signalling bell;
(4) warning lamps.

The noise-protected radio set МРП-48П employs the circuit of direct amplification and has 75 Mc/s. fixed frequency.

The sensitivity of the МРП-48П receiver keeps within 1.8 to 4 mV with a modulation percentage of 30%, modulation frequency 3000 c.p.s., and a current across the relay coil of 0.8 mA.

The current to operate the marker receiver relay does not exceed 0.6 mA ±10%, and the relay drop-out current is not less than 0.4 mA ±10%. The relay operates reliably by a current of not lower than 0.8 mA.

The plate circuits are fed with 220 V power from receivers of automatic radio compasses АРК-5 Nos 1 and 2.

A reliable indication of the marker radio beacon installed on the airfield is provided for altitudes up to 2000 m.

Except for the bell and the warning lamps, the equipment is located in the rear compartment 24.

The receiver has no control of its own and is engaged for operation when automatic radio compasses Nos 1 and 2 are energized.

Marker radio beacon МРМ-48 intended for marking the fixed points on the ground during the landing approach and gliding emits modulated and manipulated R.F. oscillations in a vertical direction.

Manipulator of the radio beacon МРМ-48 performs one of the two manipulations:

- six dots per second;
- two dashes per second.

Besides, the radio beacon transmitter can be engaged for continuous radiation.

The wave length is 4 m. (75 Mc/s.). The frequency is stabilized by quartz crystals.

The receiver МРП-48П converts the radio beacon pulses received by the antenna into pulses of 0.4 to 3.0 Kc/s. frequency and rectifies them. The relay operates upon the reception of D.C. pulses to engage the warning lamps and the bell according to the code of the marker transmitter. The warning lamps and the bell are fed from the SUPPLY (ПИТАНИЕ) plug of the receiver МРП-48П.

Marker receiver 14 (Fig.81) is mounted on a bracket on the port side between frames Nos 63 and 64. The shock absorbing plate with four shock absorbers is held to the duralumin bracket.

Inboard antenna 12 is located near the receiver between frames Nos 64 and 63 along the axis of stringer No.17.

The antenna stands on four rubber shock absorbers secured to a welded bracket which is located on stringers Nos 18 and 16. The longitudinal and transverse oscillations of the antenna body are limited by stops. The antenna is bonded with eight bonding jumpers.

The R.F. co-axial cable running from the antenna to the receiver is passed along frame 63 and is attached to the stringers.

Course Receiver KPП-Ф and Glide Path Receiver ГРП-2

Course Receiver KPП-Ф

The course receiver (phase version) is a part of the aircraft ILS intended for the reception of the airfield course beacon pulses so that the pilot might see the centre line of the runway.

The set of the course receiver (Fig.82) includes:

(1) receiver KPП-Ф with dynamotor У-18-1;

(2) control panel (common with glide path receiver);

(3) indicator ИСП-48 (two items common with glide path receiver);

(4) antenna;

(5) ILS distribution box (common with glide path receiver).

The KPП-Ф is an ultrashort-wave receiver operating on six fixed frequencies of 108.3, 108.7, 109.1, 109.5, 109.9 and 110.3 Mc.p.s.

The receiver heterodyne is stabilized by crystals.

The sensitivity of the receiver is not less than 20 μV.

Intermediate frequency 6.9 Mc/s.

The transmission band over the intermediate frequency at the level of 0.5 from the resonant value is 150 Kc/s.

Weakening of the symmetric pulse not less than 100-fold.

Operating range of the course receiver KPП-Ф not less than 70 km. at an altitude of H = 1000 metres.

Total consumption of current from 28 V main: not in excess of 3 A.

The receiver is operated by the pilot.

The KPП-Ф is an ultrashort-wave superheterodyne receiver.

The receiving antenna takes up the radiation of the airfield phase course beacon having a false spectrum with two components: directional radiation and nondirectional circular radiation.

In a horizontal plane the directional radiation of the beacon forms two areas (lobes) whose border line shows the direction of the landing course.

The directional radiation consists of ultradiofrequency pulses (side bands) modulated by 60 c.p.s. low frequency voltage in amplitude.

The modulating voltages of the two lobes are antiphased.

The non-directional circular radiation of the beacon is a pulse of the same supersonic frequency modulated in frequency by auxiliary subcarrier frequency of 10 Kc/s.

The subcarrier is, in turn, modulated in frequency by 60 cycles with ±1 Kc.p.s. frequency deviation.

The phase of 60 c.p.s. modulating voltage of the circular radiation is the same irrespective of the attitude of the airplane in space, and therefore it is termed as the radiation of constant phase.

The directional radiation whose phase changes its sign as the airplane changes from one lobe to the other is termed as the radiation of variable phase.

When the airplane is precisely on course, the receiving antenna of the KPП-Ф takes the radiation of constant phase only. In this instance, the vertical pointer of indicator ИСП-48 belonging to the KPП-Ф stands in the middle (zero) position.

As the airplane deviates from the course line to the right or to the left, the receiving antenna will take the radiation of the variable phase, too.

Depending upon the side the airplane deviates to, the 60 c.p.s. modulating voltages of the two radiations will have

either the same or opposite phases. Comparing the phases of these voltages in a special phase zoning device causes the deviation of the course indicator pointer to respective side.

The pointer deviates to the side of the course line (during the landing approach) and shows where the aircraft bias to be turned to make a correction. If the airplane is well off the runway, the deviation of the pointer shows the position of the airplane relative to the runway.

The receiving device is equipped with a distress signalling system: if the signals are lost or when the receiver is damaged, the opening of the indicator yields a white flag instead of a black one which means that the landing system will not be used.

Receiver КРП-Э is remotely controlled. The housing of the receiver consists of a chassis and two covers. All units of the receiver are mounted on the chassis. The front panel has sockets marked ANTENNA (АНТЕННА) and CONTROL (КОНТРОЛЬ) and the handle for removing and installing the set. КРП-Э receiver 26 (Fig.81) is placed in non-pressurized portion of the fuselage between frames Nos 64 and 65 along the port-side so that its base stands as high as stringer No.7. The shock mount on which the receiver is installed with the aid of four shock absorbers is rigidly attached to the rack, the shock absorbers (without the base) being secured directly to the rack by means of four bolts each. The rack is fixed to the frames with six bolts and rests on two brace struts.

The control panel is intended for remote control of the radio sets КРП-Э and ГРП-2. It is attached to the panel next to frame No.6 (port side) together with the panel of the СД-1.

Six positions of the selector on the control panel correspond to the following fixed waves of the radio sets:

Position of selector	Fixed wave of radio set КРП-Э	Fixed wave of radio set ГРП-2
1	1	1
2	2	
3	3	2
4	4	
5	5	3
6	6	

The indicators НСИ-48 are intended for indicating the course and glide slope. U-shaped antenna of the radio set КРП-Э (symmetric oscillator) with tuning element made as a shorted circuit is designed for receiving the signals of the airfield course radio beacon. The antenna is mounted in the upper portion of the fin, with the base of the fairlead resting on a special plate. It is protected with a fairing made of vitrified textolite (Fig.69).

The antenna connects to the radio set by a length of two-wire R.F. cable passed along the forward spar of the fin, and in the rear compartment Ф-4, along the stringers next to frames Nos 64 and 65 up to the peg marked ANTENNA (АНТЕННА) on the radio set whose front panel faces the stern.

The instrument landing junction box serves for electrical connection of the instrument landing system components and for power supply from the aircraft mains. The box is located on the floor, between frames Nos 5 and 6 with the aid of four screws, 4-mm dia., without shock mounts (Fig.71). The cover of the box can be easily removed.

Except the R.F. cable running to the antenna, all cables are passed along the electric wiring of the aircraft.

Glide-Path Radio Set ГРП-2 (Receiver)

The glide-path receiver ГРП-2 is intended for reception of the signals sent out by the glide-path radio beacon showing the gliding trajectory of the airplane while it is landing.

The set of the receiver ТРП-2 (Fig.81) includes:

(1) receiver ТРП-2 with dynamotor У-18-1;

(2) antenna;

(3) two indicators ПСП-48, control panel and instrument landing system distribution box which are common for the КРП-9 facility (See КРП-9 above).

The ТРП-2 is a superheterodyne ultrashort-wave receiver operating on three fixed frequencies of 332.6, 333.8 and 335 megacycles per second. Change-over from one frequency to another is accomplished by control from the panel by engaging appropriate quartz crystal.

The sensitivity of the receiver is not lower than 300 μV with two indicators ПСП-48П, and not lower than 250 μV with one indicator ПСП-48П.

Operating range at an altitude of 1000 m. is not less than 25 km.

Total current consumed by the receiver (from the aircraft mains) does not exceed 3 A.

The antenna of the glide-path receiver takes up the horizontally polarized waves of the glide-path radio beacon. In this event depending upon the position of the airplane relative to the equisignal zone, signal modulated by 150 or 90 c.p.s. frequency dominates in the antenna. The pulse received by the antenna is converted by the receiver to generate two frequencies modulated by 150 and 90 cycles per second which are rectified and produce opposite currents applied to the glide-path indicator.

While the airplane precisely follows the glide-path line (gliding trajectory), i.e. flies over the equisignal zone, the horizontal pointer of the indicator keeps to zero. When the airplane departs upward from the glide-path line, the indicator pointer comes downward, and when the airplane departs downward, the pointer comes upward. In all events, the pointer indicates the equisignal zone.

The receiving unit is provided with an emergency warning system employing a white flag (blinker) in indicator ПСП-48.

The ТРП-2 is installed in the front pressurized cabin. The receiver ТРП-2 is controlled by the pilot from the instrument landing system panel. The indications of the receiver can be seen by both the pilot and co-pilot whose instrument panels carry indicators ПСП-48.

Receiver ТРП-2 employs the superheterodyne circuit with nine tubes and quartz-crystal stabilization of frequency.

The receiver is located in the pilots' compartment on the floor, port side, next to frame No.6, near the instrument landing system panel. Receiver ТРП-2 is mounted in special tub (Fig.71). The tub with two horizontally set dowels on the rear wall moves along two shaped members riveted to the floor. The dowels enter two holes made to receive them, the front portion of the tub being fixed together with the shock mount.

The antenna of glide-path receiver ТРП-2 is intended for reception of the horizontally polarized radiation of the glide-path beacon and is presented by two horizontal oscillators. It is made of brass foil and glued up to the inner side of the navigator's glass panel (Fig.71). The antenna is not provided with tuning devices, its size being selected with a view to pass three fixed frequencies of the receiver. The antenna is connected to the receiver by means of a two-wire R.F. cable. The peg is taken off the cable end the two conductors are fitted to the connector screws. The cable is attached to the left side by means of metal clamps with rubber padding.

The protection is accomplished by circuit breaker АЗС-10 (common for receiver КРП-9) and fusible link СП-10 in wire ПВ-7 (See power supply of receiver КРП-9).

220-V dynamotor У-18-1 receiving the current from the aircraft mains feeds power to the plates of the receiver tubes.

Except the R.F. cables, the wiring is laid along the path of the electric cables and secured by means of common clips.

Section 3

R A D A R E Q U I P M E N T
O F T H E A I R C R A F T

The aircraft has the following radar equipment:
(1) aircraft transponder;
(2) radar gunsight ПРС-1;
(3) radar bombsight РБП-4.
(4) tail warning radar "SIREN-2".

Arrangement of the radar equipment in the aircraft is shown in Fig.83.

1. AIRCRAFT TRANSPONDER

The aircraft transponder of the autonomous identification system operating in a range of metre band is intended for receiving interrogation signals and for automatically sending a coded reply signals of the same frequencies. The transponder allows the interrogator to determine the following:
- whether the interrogated plane is friend or foe;
- the range to the plane.

In flight the transponder operates automatically.

It functions within a frequency range of from 160 to 170 Mc. The tuning frequency of the transponder is continuously changed. The frequency change is achieved by wobbling of a shorted turn at constant speed (variable-inductance circuit) in the circuit common for the receiving and transmitting tubes. One "wobbling" cycle takes 0.6 to 0.68 sec. During this period the transponder is consecutively tuned to the frequencies covering a band of 160 to 170 Mc. receiving the interrogator signals and sending its own signals at approximately the same frequency.

The transponder sends coded pulses in response. Every code includes a combination of narrow and wide pulses and intervals. The variation of the pulses in the code combination is controlled with the aid of the cam contactor. The transponder employs the Morse code where the narrow pulses correspond to points, and the wide pulses, to dashes. The transponder has four one-letter codes. In the coding system used letters consisting of up to four pulses each and as it is necessary to separate one letter from another, the code transmission time is divided into five equal parts within 0.6 to 0.68 sec. each corresponding to five cycles of wobbling. The fifth "wobbling" cycle invariably produces interval. The time of code transmission amounts to 3.2 ±0.2 sec. The desired code is selected by resetting the code selector on the code panel.

If the aircraft suffers distress, the pilot may send SOS signals. For this purpose the DISTRESS (БЕДСТВИЕ) switch on the code panel should be turned to ON. The distress signals last much longer than the dots and dashes, so they greatly differ from all other codes. The distress signal consists of the wide pulses only lasting for equal periods of time and has no intervals.

In case it becomes necessary to prevent the aircraft and the transponder from being captured by the enemy, the latter must be destroyed. This is done with the aid of the destructor actuated by the destructor button installed on the pilot's part console, or automatically, with the aid of the inertia contactor operating upon impact.

The set of the transponder installed in the aircraft (Fig.84) includes the following:
- transceiver;
- transmit-receive antenna;
- code panel with connecting cable;
- destructor button;
- inertia contactor;
- R.F. antenna cable.

Transponder Performance Data

Interrogator-responser range ..... 35 km.
Code used ..... Morse

Number of codes	four, and signal of distress
Time of code transmission	3.2 ±0.2 sec.
The transceiver frequency periodically changes within a range of 14 Mc. covering a band of 160 to 170 Mc.	
Power of the transmitter pulses	not less than 4.5
Period of frequency wobbling	0.6 to 0.68 sec.
Period of responding pulse:	
narrow	8 to 12 μsec.
wide	20 to 30 μsec.
Signal of distress	50 to 70 μsec.
Transponder antenna has a circular radiation pattern in a horizontal plane. Wave polarization is vertical.	
Power consumed by transponder from the aircraft mains	not exceeding 155 W

Location of Transponder Units in Aircraft

The equipment (but antenna) of the transponder is located along the port side portion of the front pressurized cabin (See Fig.83).

Transceiver 19 is installed in the lower part of the navigator-operator's panel support between frames Nos 10 and 11. The transceiver base plate is bolted to the platform on the cabin floor. The body of the transceiver is mounted on the attachment base plate and secured to it in the front lower portion of the unit with the aid of union nuts.

The transmit-receive antenna is placed in the lower part of the fuselage, between frames Nos 26 and 27. The antenna base is attached to the easily removable plate which, in its turn, is fixed to the fuselage skin with the aid of bolts. For checking the R.F. cable for reliable connection to the

...na its attachment base is removed and the antenna ...erted with one hand is lowered.

Code panel 8 is mounted on a special panel located on the ... side between frames Nos 7 and 8 within easy reach of the ...t. Located on the same board next to the code panel is ...uctor button marked DESTR, with the indicating lamp ...85); fixed under the button is the transponder power ...ly switch.

Inertia contactor 16 (Fig.83) is mounted on a rigid board ...ed on the profiles of the navigator-operator's port side ...l support next to the transceiver of the transponder.

For delivering the current to the DESTRUCTOR (DESTR) ...uit of the transponder a bunched conductor with a two-pin ... is provided. Prior to the flight the two-pin plug should ...nserted into the DESTRUCTOR (DESTR) receptacle on the ...sceiver.

All units of the transponder are connected to one another ... to the power supply sources by means of bunched conductors ... of wires, type BHBM, (coloured blue). The code panel is ...nected to the transceiver and the aircraft mains through ... plug connector which is attached to the special angle ...e fixed on the horizontal rib of the code panel mounting ...d. These bunched conductors are placed in the common ...hes of conductors of the electrical equipment running ...g the port side of the front pressurized cabin and are ...ired to the aircraft main structure with the aid of common ...gs. The R.F. cable running from the transceiver to the ...nna is laid along the fuselage port side (Φ2 and Φ3) ... attached to the fuselage stringers. A special seal is ...vided in the web of the pressurized floor of frame No.12 ...re R.F. cable running to the antenna passes through the web.

The R.F. cables are connected to the transceiver with the ... of R.F. angle connectors with a view to decreasing the ...ng radius of the cables in question.

The transponder is fed from the 26 V aircraft mains ...gh two-circuit bus bar of the co-pilot's panel circuit

breaker via circuit breaker A3C-5. This circuit is provided with switch B-45 installed on the code panel (port side) within the pilot's reach. The feed circuit is also provided with filter Ф-14А to reduce radio interference of the aircraft mains.

The destructor circuit is fed from the storage battery bus bar in the storage battery junction box located next to frame No.17.

Designation and Functioning of Transponder Units

Transceiver is intended to receive non-coded interrogator signals and to automatically send coded signals in response. The transceiver includes the transceiver proper and the supply unit.

The transceiver has the following five channels:

(1) transmit-receive channel;
(2) sensitivity automatic stabilization channel;
(3) carrier-blocking channel;
(4) coding control channel;
(5) response indication channel.

CODE PANEL serves for changing the codes and for governing the transponder operation.

Antenna is a flat shortened dipole of streamline shape with a tuning element.

Destructor button is designed for destroying the transponder and for checking the destructor circuits. Indicating lamp is installed together with the button, on the same base.

The button is pressed to destroy the coding equipment of the transceiver. The indicating lamp shows the condition of the destructor circuit.

WARNING: The plug should never be inserted into the detonator receptacle while the indicating lamp is on, as in this event the transponder will be destroyed!

The indicating lamp lights upon pressing the destructor button or upon the operation of the inertia contactor. In the above case the plug receives the voltage from the storage battery junction box bus bar.

Inertia contactor serves to automatically close the detonator circuit when the airplane suffers distress over the enemy area. The inertia contactor consists of a pendulum, pendulum lever, springs and two contacts. Normally the pendulum keeps the lever in the armed position and the contactor contacts are open. When the airplane impacts the ground with an acceleration of 10 g, the inertia contactor contacts close, the current to the plug is supplied from the storage battery junction box bus bar and the indicating lamp lights up.

2. RADAR GUNSIGHT ПРС-1 (UNIT АРІ7)

Radar gunsight ПРС-1 ensures, irrespective of the visibility conditions, automatic search, lock-on and tracking of the target and automatic delivery of the data to the ПВБ-53 computer; the data are required for aimed firing from the tail common mount against the attacking plane within a zone of $\pm 35^{\circ}$ in azimuth and at angle of sight from the side of the rear hemisphere.

The sight transmitter generates powerful pulses of R.F. energy which the waveguide carries to the antenna radiator to emit into space.

The antenna angular travel in azimuth and its tilt are ensured by means of antenna rotator actuated by the controlling voltage which is generated by the automatic search mechanism.

The antenna is scanning to search the space within the desired limits. The target appearing within the zone of search reflects the energy that radiates it. The sight antenna receives part of the radiated energy, and the antenna receiver converts the R.F. pulses first into an intermediate frequency of 10 Mc. and then into video pulses of the target which is sent to:

(1) the indicator for obtaining the target marking;

(2) the protector that guards the sight against non-synchronous pulse interference produced by radars operating in 3-cm. range.

The protector output directs the video pulses of the target to the range computing mechanism where they are selected according to the distance and sent to the angle tracking mechanism.

The target having been detected, the searching mechanism is automatically disconnected and the sight changes over to tracking the target.

During the target tracking the antenna of the sight is automatically directed towards the target. The antenna revolution is governed by the angle tracking mechanism which generates controlling voltages proportionate to the angle of the target departure from the equisignal direction of the antenna.

The controlling voltages are supplied to the antenna rotator. The sight antenna rotates to decrease the difference between the mismatching angle and the direction towards the target.

Apart from the autonomous employment of the sight the sight antenna may be scanned to the target with the aid of the optical sighting station controlled by the operator-gunner who uses the optical sight. The sight antenna having been scanned to the target, the radar sight looks on the target then automatically gets disconnected from the optical sight and switches over (as in the case of the autonomous employment) to automatically tracking the target.

When tracking the target, the radar sight transmits to the computer the data of target bearing, angular velocity and the range to the target.

Main Performance Data of the Sight

During an automatic tracking of the target the sight ensures the following:

Target locking-on range while scanning	3.5 km.
Maximum zone of search in azimuth and elevation	$\pm 35^{\circ}$
Scanning time of search zone	not exceeding 16 ± 3 sec.
Possible change of the value and angular position of the search zone	within ± 20 to $\pm 35^{\circ}$ of the area scanned
Automatic tracking of the detected target with errors not exceeding 70 m. of range and 14 min. of arc of angular coordinates with a range to target	from 800 to 1500 m.
Resolution in range	not less than 200 m.
Resolution in angle	not less than 8°
Minimum coverage	not exceeding 250 m.
Operating frequency generated by the magnetron	9370 ± 30 Mc.
Power of the main radio pulse	not less than 40 kW
Duration of main pulse	0.5 ± 0.05 μsec.
Main pulse repetition rate	1920 to 2080 c.p.s.
Intermediate frequency	30 Mc.
Weight of the sight	170 kg

Designation of Units of Radar Sight NPC-1

The radar gunsight includes twenty one units with cables.

1. Unit AP17-1 (antenna) is intended to perform the following:

(a) radiating radio pulses of the transmitter and receiving the radio pulses reflected from the target;

(b) obtaining equisignal direction in space;

(c) searching and tracking the target in the zone of scan;

(d) transmitting angular coordinates of the target to the indicator, gyro instrument and computer synchronously;

(e) supplying the sweep voltage to the indicator and the angular tracking unit.

2. Receive-transmit unit РП1-2 is designed to perform the following:

(a) generating powerful radio pulses;

(b) switching over for transmission and reception;

(c) converting the pulses reflected from the target and received by the antenna into intermediate frequency pulses and preamplifying them;

(d) supplying the starting pulse for actuating the circuit of the automatic frequency governor, reception keying circuit, and forming the controlling pulses in the receiver-indicator unit.

3. Receiver-indicator unit АР17-3Д serves for the following:

(a) amplifying and converting the pulses reflected from the target;

(b) synchronizing the functioning of the sight units;

(c) changing the sight over to the firing control mode of operation.

4. Indicator АР17-4Д with the control panel:

(a) indicates the targets coming within the field of vision of the sight and determines the distance to them;

(b) indicates the lock-on and tracking of the target;

(c) indicates the antenna tilt while the sight is engaged for searching and tracking of the target;

(d) performs the aiming control of the sight.

5. Junction boxes АР17-5 and АР17-6 are provided for interconnection of the sight units.

6. Control panel АР17-7Д:

(a) governs the main supply voltages of the sight, magnetron current, currents of the first and second crystal detectors, computing the range to the target, antenna revolution speed, control range and the pressure of the air in the TRANSMITTER - ANTENNA (ПЕР ДАТЧИК - АНТ ЛИНИЯ) waveguide system;

(b) switches the sight over for the control mode of operation with a view of determining whether the sight is serviceable.

7. Gang box АР17-8Е is designed to perform a connection between sight ПРС-1, computer and the tail sighting station.

8. Amplidynes АР17-9Д ensure amplification of the controlling voltage of the angle tracking unit and transmission of the amplified voltage to the antenna motors.

9. Angle tracking unit АР17-10Д:

(a) extracts the error signal;

(b) compares the error signal with the reference voltage and sends D.C. pulses for rotating the antenna;

(c) changes the sight over for target tracking mode of operation;

(d) performs angle tracking of the target.

10. Range and search control unit АР17-11Д:

(a) determines the range to the target as expressed through the D.C. voltages;

(b) performs automatic range tracking of the target;

(c) controls the antenna rotation in the automatic scanning mode of operation.

11. Supply unit АР17-12Д:

(a) converts 115 V, 400 c.p.s. alternating current into rectified voltages of +300 V, +230 V, +150 V (1), +150 V (2), -150 V;

(b) regulates voltages of +300 V; +150 V (2), -150 V.

12. Unit АР17-13Д serves to connect the sight to the A.C. and D.C. centralized mains of the aircraft.

13. Search control panel АР17-14Д serves for governing the antenna revolutions in the automatic scanning mode of operation.

14. Firing button AP17-16 is provided for connecting the turret control circuit to the remote control system.

15. Remote control panel AP-17Д is intended to switch over the gun-sight modes of operation:

(a) autonomous functioning of the radar gunsight when set at RADAR (РАДИО);

(b) aiming of the antenna at the target with the aid of the optical gunsight when set at AIMING (НАВОДКА);

(c) governing of cannon directly by optical sight when set at OPTICAL (ОПТИКА).

16. Gyro instrument AP17-19Д serves for determining the target angular velocity (in a horizontal and vertical planes).

17. Servo unit AP17-20Д is provided to control the azimuth and tilt motors of the gyro instrument.

18. Range transmitting unit AP17-21Д supplies voltages of the range to the ПВБ-53 computer.

19. Set of cables AP17-15 for connecting the sight units.

Location and Installation of Radar Gunsight ПРС-1 in Aircraft

The sight units are located in the rear pressurized cabin and outside of the pressurized spaces of cabins Ф6 and Ф4 (Fig.86).

Antenna AP17-1 is mounted on the outer surface of the pressurized cabin horizontal plate so that the reflector and the antenna radiator face the aircraft tail and the centre line of the unit runs parallel to the aircraft axis (the mark on the antenna base brought against the mark on the plate), its tilting angle amounting to minus 34 ±3. The antenna base is attached to the special assemblies of the airframe with the aid of three bolts; the antenna is tilted by means of levelling washers, 0.1 to 0.15 mm thick.

Transceiver РП1-2 is bolted (Fig.87) to two profiles of plate Ф6 and connected to the AP17-1 unit by means of waveguide AP17-25. The waveguide is equipped with a clamp and a supporting holder that are set with a view to obviate the bending stresses arising as the transceiver mount reacts to shocks.

Gyro instrument AP17-19Д (Fig.87) is mounted next to transceiver РП1-2, between frames Nos 72-73. Its base is secured to two sections on the horizontal plate so that the mark made on the unit and the hinged base is aligned with the mark on the horizontal plate.

Units AP17-16, AP17-7Д, AP17-8E, AP17-14Д and AP17-17Д are located on the starboard of the rear pressurized cabin, between frames Nos 73-75.

Unit AP17-4Д is installed in the rear pressurized cabin on a special plate hinged to the armoured plate of frame No.75, starboard. Due to the hinged device the unit can be brought to the operating and to the stowed positions. Besides, the unit body together with the attachment frame can travel to the right relative to the gyro instrument, which enables the operator to bring the unit screen opposite his eyes.

Units AP17-5, AP17-6, AP17-21 and AP17-13Д are mounted on the port side of plate Ф4, between frames Nos 60 and 62a. These units are secured to the brackets on the cabin airframe.

Unit AP17-12 (Fig.88) is installed on a special support on the port side section of plate Ф4 next to frame No.62a.

Units AP17-20, AP17-11, AP17-3Д, AP17-10 are arranged on the brackets of the support installed on the port side of plate Ф4 along the axis of frame No.61 (Fig.89).

Note: This support is provided to carry unit AP17-22 and special spare holders of the delay line. Mounted on the support is also cooling fan ДВ-3 of the unit for cooling the sight on the ground.

Amplidyne unit AP17-9Д is mounted under the support carrying the units; it is placed on bracket connected to the stringers of the aircraft airframe.

Mounted near the support is a special vertical post intended to protect the units arranged on the support against blows and jerks that might affect the units when the cannon ammunition is loaded.

From the outside units AP17-1, РП1-2 and AP17-19Д are protected with special metal cowls having removable panels giving access to the units. The operating section of the AP17-1 antenna (its reflector) is protected with easily removable cowl made of dielectric.

Two fans ДВ-3 are installed above the РП1-2 unit for cooling it when sight ПРС-1 is operated on the ground. The fan is engaged when the tail bumper is extended and is disengaged when the tail bumper is retracted.

All units of sight ПРС-1 are interconnected and connected to computer ПВБ-53 and to power supplies with the aid of shielded, high tension and high frequency cables and wires БПВЛ painted blue. The plug connectors of every cable are engraved to indicate cable and unit numbers for connection. Such cables pass through the web of frame No.69 and the ceiling of cabin №6 via sealed two-receptacle connectors. The plug connector numbers are written in red enamel close to the connectors on the frame web and cabin ceiling.

The cables are attached to the airframe, plates and supports with the aid of clamps with shaped rubber pieces and bonding strip.

The cables running to units AP17-19Д and AP17-4Д are made long enough to ensure transfer of the units without disconnecting them as may be required for operation.

The portion of the shielded cable near unit AP17-4Д is protected with a piece of canvas wound about it so as to protect the cable against fraying when the unit is shifted.

For suppressing the interference the jacket of every unit has a special terminal labelled GROUND (ЗЕМЛЯ) connected to the aircraft main structure by means of a bonding jumper.

Power Supply of the Sight

Radar gunsight ПРС-1 is fed from 28 V aircraft D.C. mains, or 115 V, 400 c.p.s. A.C. mains. The 28 V supply is delivered by two special cables and units AP17-13Д and AP17-9Д to the following circuits of the sight:

(1) excitation windings of the azimuth and antenna tilting motors;
(2) antenna radiator rotating motor;
(3) fans of unit РП1-2;
(4) heating elements of unit AP17-19A;
(5) amplidyne motors of unit AP17-9Д;
(6) a large number of relays of various units of the radar gunsight.

115 V, 400 c.p.s. current is supplied through unit AP17-5 to junction box AP17-5 whence it is delivered to the units of the radar gunsight provided with rectifiers.

Unit AP17-9Д is fed from the 28 V circuit breaker panel bus bar of the rear pressurized cabin through circuit breaker СЗ-40. Unit AP17-13Д receives power from plug connector No.31 fed from the 28 V circuit breaker panel bus bar of rear pressurized cabin via circuit breaker АЗС-20, and from A.C., 115 V, 400 c.p.s. bus bar through plug connector No.43 of the navigator-operator's fuse panel via fuse СП-15.

Gang Operation of Radar Gunsight ПРС-1, Computer ПВБ-35 and Armament System

The cannon mounts are governed with the aid of the remote control selsyn drive through two channels (coarse and precise).

The coarse selsyns are connected to the antenna shafts by means of gear train having gear ratio of 1:1, and the precise selsyns, by means of the gear train having gear ratio of 31:1.

Radar sight ПВБ-53 is connected to the ОПС unit through gang box АР17-8Е. Sight ОПС is connected to radar sight ПРС-1 when the selector on the АР17-17Д unit is brought to LAYING (НАВОДКА). The circuits of the radar gunsight are connected to the circuits of the ПВБ-53 computer in the laying and the target lock-on modes of operation, unless the selector on the АР17-17Д unit is set at OPTICAL (ОПТИКА).

Air Supply System of Radar Gunsight ПРС-1

To compensate the air leakage and to maintain normal atmospheric pressure inside transmit-receive unit РП1-2 and waveguide АР17-25 when the aircraft is flying at altitudes not less than 3000 m. mounted in the plane are duralumin pipes and rubberized hoses for delivering compressed air ($1.1^{+0.1}_{-0.2}$ kg/sq.cm.) to the valve-fitted connection of unit АР18-2 from the seventh stage of the engine compressors via the pressure reducer (unit 436).

The air supply system of the ПРС-1 radar gunsight is controlled by means of the valve labelled ARGON SUPPLY (ПОДКАЧКА АРГОНА) and installed next to frame No.73. The gunner should open the valve every 30 min. of operation.

The air pressure in the units is controlled with the aid of the indicator on unit АР17-7Д using the selector of the unit.

3. RADAR BOMBSIGHT РБП-4

Radar bombsight РБП-4 is designed for searching and detecting the ground and surface targets irrespective of the optical visibility conditions for solving the navigation tasks with the aid of radar recognized terrain marks and for precision bombing of ground and surface targets (stationary

and moving) with an automatic bomb release at altitudes of from 3000 m. to 15000 m.

The bombsight equipment is fully synchronized with optical sight ОПБ-11р, and its sighting plane is stabilized by the optical sight vertical gyro the bank angles do not exceed 10°.

Radar bombsight РБП-4 consists of 16 units shown in Fig.90 and described below.

Radar Bombsight Performance Data

Operating range:	
when detecting and identifying large objects	140 to 180 km.
when sighting	70 km.
when operating with the target identification beacon	to be determined by direct visibility at maximum flight altitude
Sighting method	synchronous, employing mechanisms of optical sight ОПБ-11р
Bomb release method	automatic, through the contact system of optical sight and electrical bomb release system
Bombing altitudes when using optical sight ОПБ-11р	3000 to 15,000 m.
Bombing speed range	300 to 1250 km/hr
The sight may operate on two fixed waves switched over as required	
Searching in azimuth:	
circular scanning	through 360°
sector scanning (50°)	within front zone (±65° as from the path of flight)
Frequency band	9310 to 9430 Mc.

Pulse power	90 kW as minimum
Duration and recurrence of pulses	0.45 μsec. and 1250 c.p.s. for ranges of 10, 20, 10 to 70 km.; 1 μsec. and 535 c.p.s. for ranges of 100 and 200 km.
Antenna angular velocity in azimuth plane:	
during continuous rotation	20 r.p.m.
while scanning	12 r.p.m.
Frequency of antenna wobbling during sector scanning	45 per min.
Angles of antenna tilt	from +5° to -25°
Power consumed from aircraft mains (28 V)	3 kW

Principle of Operation of Radar Bombsight

The operation of the РПБ-4 radar bombsight is based on employing radio waves reflected from the objects that stand in their way.

The radar antenna periodically emits powerful transient pulses. The pulses reflected from the surface of the ground are taken by the same antenna to be sent to the indicating devices after appropriate amplification. The screen of the cathode-ray tube indicator yields the radar-presented image of the locality the aircraft is flying over.

The radar and fixed antenna are engaged to sweep a narrow strip of the ground, but when the antenna is rotated by the motors a circular area of large radius is consecutively swept. 1-cm. waves propagate following a rectilinear pattern, therefore the distance to the target (slant range) can be determined by the time needed for the pulses radiated to reach the object and come back to the emitter. The direction towards the reflecting object is determined by the azimuth position of the antenna at the moment the reflected pulse has come back.

The radar equipment employs the indicators with radial-circular scan and B-scan.

The operator can choose one of the five scales ("10", "20"; "10" - "70", "100" and "200" km., depending on the distance to the target).

The indicator is provided with luminous circles (range marks).

Course line. The rotation of the sweep trace on the indicator is synchronized with the rotation of the antenna. When the antenna is rotated, the moment the antenna bearing coincides with the aircraft fore-and-aft axis may be marked on the screen with a bright radial line (course line). The azimuth angle between the course line and the direction to the target is determined by means of the course line on the screen, rotary light filter (with the marks made on it) and rotary scale (graduated in degrees from 0° to 360°).

Sector scanning. The operator may use the sector scanning mode of operation besides the circular scanning whenever it may be required to study a certain site on the area searched. In this event the antenna (and the sweep line on the indicator screen synchronized with it) start wobbling within the limits of the sector. The sector display is mainly used when the aircraft is on the bombing run.

Navigation. Special radar maps (or ordinary maps) should be used for decoding the image produced on the indicator screen.

Apart from homing on an object or on a pulse radio beacon radar bombsight РПБ-4 enables the operator to solve a number of navigation problems, the principal ones being the determination of the aircraft coordinates and of the flight true airspeed and drift.

Bombing. The radar sight solves the problems of precision bombing employing the navigator's equipment used in conjunction with optical sight ОПБ-11р. The searching and target determination are usually accomplished by the navigator-operator who uses his own indicator; the lateral aiming and

aiming in range are done with the aid of the navigator's indicator. The navigetor's indicator P8 is a sighting arrangement of radar bombsight РБП-4.

Units РБП-4 installed within the navigator c easy reach and convenience ensure two modes of sight operation (searching and homing).

When employing the optical sight operating in conjunction with radar bombsight РБП-4, the sighting may be done both with the aid of the telescopic arrangement of optical sight ОПБ-11р and the navigator's indicator screen.

The bombing problems are solved by means of the computing mechanisms of optical sight ОПБ-11р.

The bomb ballistic data, corrections for the train and aircraft formation are introduced into the mechanism of sight ОПБ-11р. The bombs are released automatically.

The operation of the radar bomb sight is best understood by reference to the service manual of "RADAR BOMBSIGHT РБП-4.

Location and Installation of Radar Bombsight РБП-4

The units of the radar sight are installed in the front pressurized cabin and also outside of it at the bottom of the fuselage.

Depending on the control employed, the units of the radar bombsight are mounted within the reach of the navigator-operator and the navigator (See Fig.83).

The units forming the set of the radar bombsight (except the P1 antenna, transceiver P2, modulator P12, junction boxes, control panels and indicators) are provided with shock-mounted mounting frames which are bolted to the aircraft main structure when the units are installed in the aircraft. The body of the unit is inserted into the mounting frame along two guides and secured to the frame with two shaped union nuts fitted in the lower front portion of the unit. Every unit has a terminal marked GROUND (ЗЕМЛЯ) connected to the airframe or the control panel support with the aid of a bonding jumper.

Antenna (unit P1) 14 together with the attachment plywood board carrying the mechanisms and the reflector of the unit is arranged in the lower portion of the pressurized cabin in a recess between frames Nos 5 and 8. Mounted on the webs of frames Nos 6 and 7 are two L-shaped sections to which the attachment board of the antenna is secured with six bolts. The attachment board of the antenna has a notch (marking the position of the antenna axis) that must coincide with the aircraft longitudinal axis.

The portion of the antenna projecting outside (reflector) is protected with a cowling made of dielectric which is secured to the fuselage skin. To protect the crystals of the P2 unit from the antenna radiated pulses while scanning the rear sphere of the aircraft, a reflecting duralumin plate is mounted slantwise on the vertical web of frame No.8.

Transceiver 15 (unit P2) is installed in the front pressurized cabin, under the pilots' seats, between frames Nos 8 and 9 (Fig.91). The unit is installed on two L-shaped bars and secured to them with four bolts.

Unit P2 is connected to unit P1 by a waveguide passing through the web of frame No.8 via sealing gasket.

Modulator 17 (unit P12) is located (See Fig.83) in the front pressurized cabin, between frames Nos 9 and 10, starboard (Fig.85). The shock absorbers of the unit are locked to four brackets cast of magnesium alloy and mounted on the web of frame No.9 and the shaped members of the operator's panel support. The unit shock absorbers are secured with the aid of four 10-mm bolts.

Junction boxes 2, 10, 7 (Fig.83), or else units P15, P14, and P13, are issued by the Manufacturer with the set of cables to be connected to the radar bombsight units to ensure connection between radar bombsight РБП-4 and the aircraft mains, camera ФАРЛ-1 and optical sight ОПБ-11р. Junction box P15 is placed on the bottom piece of frame No.12, port side portion is viewing forward, and secured to the angles on the stringer

bottom pieces with four bolts. Junction box P13 is fixed to the web of frame No.9, port side portion, and is bolted to the angles on the frame web. Junction box P14 is mounted on the port, between frames Nos 4 and 5 (under the navigator's table); it is fixed to two brackets connected to the fuselage stringers.

Control panel 3 (unit P6) is installed on the port side portion of the front pressurized cabin, between frames Nos 10 and 11 above the units placed on the operator's panel support (Fig.92). Unit P6 is mounted between two brackets on a special plywood plate and is hinged so that it may swivelled (Fig.93). When the unit is engaged in operation the front panel faces the operator end is locked with the aid of a special stop.

When the stop is retracted the panel swivels so that its front face stands against the cabin boardside thereby providing access to the units mounted on the panel support of the operator.

Indicator 1 (unit P5) of the operator (Figs 83 and 92) is arranged on the port side wall of the cabin next to frame No.12. The unit is secured with the aid of a slide that moves along the guiding rail towards the cabin side from the operator, or towards the operator. A screw is provided on the right side for locking the unit. Unit P5 is tilted relative to a vertical plane by means of a screw fitted on the front portion of the unit attachment fixture.

The screen of additional indicator P5 is photographed with the aid of special camera ФА-РД-1 (Fig.94) which is done with a view to controlling the functioning of radar bomb sight РБП-4. This requires that unit P5 should be attached to the camera in question. The screen of the unit is placed parallel to the camera objective.

Unit P5 is attached together with the attachment fixture of camera ФА-РД-1. The whole mount is arranged between the right panel support of the operator and the bottom piece of frame No.12.

Units P3, P4, P11, P10 are installed on the shaped members of racks of the operator's left panel support. Units P11, P4 and P3 are mounted one after another on the upper rack of the left panel support. Unit P10 is installed on the rack under the units.

Synchronizer 13 (unit P7; see Fig.83) is placed under the control bridge of the pilot next to frame No.5 as viewed from the side of the navigator's cabin. The mounting frame of the unit is secured to the two plates which in turn are bolted to the bracket on the floor of the cabin under the control bridge.

Navigator's control panel 12 (unit P9) is mounted on the port side of the pressurized cabin, between frames Nos 3 and 4 under the navigator's table). The base of the control panel is attached to the bracket that is connected to the stringers of the fuselage (Fig.95). During operation unit P9 may be pulled out nosewise (Fig.96).

Indicator 11 (unit P8; see Fig.83) is installed in the front upper portion of the pressurized cabin on the left of the aircraft fore-and-aft axis.

The mounting base of the unit is secured to a carriage which slides along a guiding rail together with the unit. The unit is fixed to the side portion of the carriage with the aid of a screw. Its position may be changed relative to a vertical plane and azimuth (Fig.97). To obviate striking of the P8 unit (in the drawn-out position) against sight ОПБ-11р which may be caused by vibrations of the aircraft, the unit body is attached to the guiding rail with the aid of a shock-absorbing hose.

Arrangement of Radar Bombsight Cables in Aircraft

The radar sight cables are secured to the frames and stringed members of the control panel supports installed on the port side of the cabin with the aid of special clips.

The cables running to units P8, P9, P6, P3, P4, P11, P7 provide for their free movement. The cables that are shifted during operation of the units are protected with canvas covers.

Power Supply of Radar Bombsight

Radar bombsight PBП-4 receives power from 28 V D.C. aircraft mains and from 115 V, 400 c.p.s. A.C. mains. The feeding is accomplished through junction box (unit P15). The box is connected to the aircraft mains by means of cable No.18 via two relays K25A of the feed circuits for A.C. and D.C. in the relay box of radar bombsight PBП-4, on the left panel support of the operator. The feed circuits passing through A.C. relay K25A are protected by fuse СП-15А installed in the fuse junction box of the operator; the D.C. feed circuit is protected by circuit-breaker A3C-20A installed on the circuit-breaker panel of the operator.

Units of Radar Bombsight

Antenna equipment (unit P1) is intended for directed radiation of R.F. pulses and for reception of the reflected pulses. The antenna equipment consists of R.F. portion and the gear for azimuth rotation and tilting end of the equipment for transmitting the azimuth and tilt data.

The waveguide system of the antenna is designed for transmitting the R.F. energy from the transmit-receive unit to the antenna, and vice versa.

Transceiver (unit P2) is used:

(a) for generating powerful short pulses of radio frequency and for transmitting them to the antenna;

(b) for superheterodyne reception and preamplification of the reflected pulses taken by the antenna;

(c) for converting the R.F. pulses of the magnetron oscillator into the R.F. pulses controlling the system of automatic frequency control.

Range unit P2 is intended for pulse shaping, for starting the modulator and the sweep circuit in the operator's synchronizer, for sweep delay and for stage delay of the range stop. Besides, the range unit produces the range marker for precision bombing and two-, ten-, and twenty-kilometre scale marks.

Operator's synchronizer (unit P4) is designed for amplification of the I.F. pulses (converted into video pulses and then amplified) for obtaining the sweeps on the operator's indicator, camera ФА-РП-1 and the navigator's indicator (when engaged for scanning) for automatic frequency control duties.

Operator's indicator and camera ФА-РП-1 (units P5/1 and P5/2) are intended for observing the radar presentation of the landscape, range markers, sighting markers, scale marks, course line, and the IFF equipment pulses yielded by their screens.

Operator's control panel (unit P6) is designed for governing the equipment and controlling its functioning, i.e. connecting and disconnecting power supply, connecting and disconnecting the transmitter, controlling the antenna, selection of the modes of operation, tuning of the receiver, adjustment of the brightness of the markers and the like.

Navigator's synchronizer (unit P7) is intended for producing and shaping the sighting marker, for synchronous lighting, for shaping and amplifying the video pulses sent to the control electrode of the indicator tube, for generating the voltage of sweep in the navigator's indicator. The synchronizer is connected to indicator P8, navigator's control panel P9 and bombsight ОПБ-11р via junction box P14.

Navigator's indicator (unit P8) is a combined instrument serving for searching and homing duties.

When engaged for the searching mode of operation, it is intended for showing on its screen the radar presentation of the locality, range markers, sighting markers, and the pulses sent by the identification equipment.

When engaged for the homing duties, the indicator is used as a sighting equipment of radar bombsight РБП-4 serving for the navigator for performing all operations concerned with lateral aiming and aiming in range accomplished with the aid of observing the display on the indicator screen.

Navigator's panel (unit P9) accommodates all calibration adjustable potentiometers and vital controls of the navigation equipment.

High-voltage rectifier (unit P10) is designed to feed the cathode-ray tubes of indicators P5/1, P5/2 and P8 (+4300). The rectification circuit employs a half-cycle rectifier.

Rectifier (unit P11) is provided to feed the units of the sight with stabilized voltages of +300 and -300 V and with non-stabilized voltage of +400 V.

Plus 300 V stabilized voltage is supplied to local oscillators and the anode circuits in unit P2, anode circuits of tubes of units P3, P4, P7, P5/1, P5/2, the circuits for adjustment the focusing and brightness of indicator P8, the potentiometers of control panels P6 and P9. Minus 300 V voltage is supplied to the bias circuit of unit P7, the heterodyne tubes of unit P2, and the operator's synchronism automatic frequency control. The sweep amplifier in synchr P4 consumes a non-stabilized voltage of +400 V.

Modulator (unit P12) is intended for shaping the high voltage pulses modulating the transmitter magnetron generators and for shaping the pulses starting the navigator's synchronizer and the IFF equipment.

Air Supply System to Radar Bombsight РБП-4

Regular operation of receive-transmit unit P2, antenna waveguide and modulating unit P12 at flight altitudes of

m. and higher requires that the leakage of air from units should be made up so that the pressure equal to on the ground is maintained. For this purpose air is ed from the seventh stage of the compressor of engine when it is compressed to 6 kg/sq.cm. and is delivered to valve-equipped connection of modulator P12 from the -way union of the distributor (the union is common with system of radar sight ПРС-1 via the pressure reducer it 436) where the pressure of the air is reduced down $1.1^{+0.1}_{-0.2}$ kg/sq.cm.; the air is delivered to the modulator ection by means of tubing equipped with air strainers, and dehumidifiers.

The air supply is controlled by the navigator-operator the aid of valve marked AIR SUPPLY (ПОДКАЧКА) and talled within his easy reach.

The air supply system operation is checked by watching indicator installed on the control panel: when the indi- shows a pressure drop, the valve should be opened, and the pressure jumps up to the normal value the valve ld be closed.

Dehumidifier (Fig.99) is installed under unit P12.

In some aircraft the air is supplied to the sight by an omous pump engaged as soon as the air pressure drops. functioning of the air supply system is checked by the ing lamp marked PUMP ENGAGED (ПОМПА ВКЛЮЧЕНА); the lamp installed on control panel P6.

4. TAIL WARNING RADAR "SIRENA-2"

The tail warning radar is intended to warn the members the crew that the aircraft is being radiated by the radar ing unit[x/] or radar sight of enemy aircraft flying r it.

x/ To be referred to as D.M.E. (distance measuring ent).

The warning is effected aurally, through the aircraft intercommunication system or the monitoring circuit of radio set PCMY-3M.

The sound signal tone changes indicate whether the radiating aircraft is approaching or retiring.

Performance Data of the Tail Warning Radar

1. Operating range ..... from 3.15 to 3.45 cm.
2. Sensitivity of the radar within the operating range at the pulse duration of 0.5 μsec. and a frequency of 1000 c.p.s. ..... not less than $0.13A10^{-5}$ W
3. Angle of aspect in a vertical and horizontal planes of the rear hemisphere ..... 50 to 80°
4. Power supply ..... 28 V aircraft mains
5. Power consumed ..... 50 W
6. Weight of the radar set less cables ..... 6 kg

Principle of Operation

The tail warning radar is a crystal receiver with a pulse amplifier and audio signal stages. The pulse taken by the antenna via the R.F. connector is sent out to the germanium rectifier and then to the pulse amplifier. From the last stage of the amplifier the pulse passes to the integrator. The pulses generate a pulsating voltage at the output of the integrating circuit whose amplitude is proportionate to the power of the signal received, the ripple frequency equals the pulsed frequency.

The voltage from the integrator output reaches the audio signal channel.

The audio signal channel consists of a multivibrator and audio frequency amplifier.

The multivibrator does not generate pulses when there is no grid voltage of the control tube.

It starts oscillating upon application of pulses exceeding $0.43 \cdot 10^{-5}$ W to the control tube grid.

The change of the pulse power brings about the change of the multivibrator oscillating frequency.

Upon reception of the pulse the input frequency of the main multivibrator is an intermittent sequence of pulses whose recurrence frequency is a function of the power of the pulses received, the interruption frequency being a function of the circuit components of the modulating multivibrator.

The voltage from the main multivibrator input is amplified in the audio amplifier and is delivered to the control panel from the main multivibrator output via the amplifier connector.

The tail warning radar set includes a gang unit intended to prevent the inadvertent operation of the radar that might be caused by functioning of radar bombsight PBП-4 and radar ПРС-1 gunsight.

The gang unit receives the pulse sent out for starting the tail warning radar. After having been converted the pulse is sent out to the integrator of the main unit, thus obviating the oscillation of the main multivibrator and hence the appearance of the audio pulses at the output of the amplifier-and-indicator unit caused by the signals delivered to its input synchronously with the delivery of the pulses to the input of unit No.4.

From the control panel the frequency audible signals are sent out to the intercommunication system of the aircraft through the divider and to radio set PCMY-3M through the regulator.

Description and Installation

The antenna is a section of the waveguide whose power is transferred with the aid of the loop; it is made integral

with the crystal receiver head, the connection being accomplished by means of a rigid coaxial section.

The antenna and the amplifier-and-indicator unit are mounted on the port side stabilizer.

The amplifier-and-indicator unit is coated with varnish for protection against moisture.

The control panel is a box with a warning lamp arranged on its side wall indicating the engagement of the station. The side wall of the box also mounts two toggle switches. One of the toggle switches serves for engaging the gang units, and the other, for connecting the audible signal system.

The gang unit is made as a box with a partition on its base for mounting tubes. The wiring and the inner portion of the unit are coated with moisture-proof varnish.

The unit for gang operation with radar bombsight РБП-4 is installed on the starboard, next to unit П12, and the unit for gang operation with the radar gunsight, in the tail portion of the aircraft, next to unit АП7-12Д.

Section 4

REDUCTION OF INTERFERENCE LEVEL ON THE AIRCRAFT

1. REDUCTION OF INTERFERENCE LEVEL CAUSED BY STATIC ELECTRICITY

To eliminate the causes of the dangerous discharges of static electricity, efforts should be made to obtain electric integrity of the aircraft and smooth (sparkless) outlet of the static electricity into the atmosphere. The former is achieved by employing bonding fixtures, and the latter, by static electricity dischargers.

Besides, the aircraft is provided with the following:

(a) automatic charge removers which connect the aircraft structure to the ground as the aircraft touches the runway. In the process of operation, the charge removers should be

properly maintained, because the aircraft remains charged after returning from the flight if they are out of order, as the rubber tires insulate the aircraft from the ground;

(b) special grounding wires, one of which is thrown from the aircraft before extending the ladder and the other is used to earth the aircraft for parking. The first wire is in special bag of the navigator-radar-operator on frame No.12, and the other (in a similar bag) is in the well of the nose landing gear.

WARNING: It is prohibited to extend the ladder from the aircraft, to touch the latter and to leave it until the first grounding wire has been thrown out.

Bonding of the aircraft is effected:

(a) by directly connecting the separate metal components of the aircraft structure with the aid of bolts, or rivets when manufacturing the aircraft, provided these components do not move relative to each other in the process of operation;

(b) by connecting the components to each other with the aid of bonding strips, provided the latter are made movable.

The bonding strips are made of tin-plated copper braiding of three types (П6х10, П10х16 and П16х24) having various lengths. The length is determined by the minimum distance between the points to be connected taking into account the possibility of their travel relative to each other.

The identification marks (spots, strips and dots) made on the bolts and terminals of the bonding strips in red paint serve for checking the quality of the bonding equipment in the process of operation. These marks indicate the contacts which in the process of operation must undergo the inspection.

The components of the aircraft structure are mainly bonded with the aid of rivet joints which does not require the installation of any additional equipment. Ten per cent of the rivets are not anodized with a view to ensure a reliable electrical connection of the rivet joints holding the skin

to the stringers, spars, frames and ribs, connecting the spar bands and rib bands to their webs, and the like. Such rivets are not used in the rivet joints of smaller brackets, stiffeners, control panels, boxes, and the like.

Butt and attachment bolt connections are used for bonding the components of the airframe.

Bonding of the elements of control (rigid members) is effected by connecting them to the airframe with the aid of the bonding strips.

Bonding of the elements of control (cables) is effected by metal sheeve blocks installed in addition to the textolite ones and by contacting the cable terminals to the elements of control and the controlled units.

Bonding of the movable units (rudders and elevators, ailerons, trim tabs, bomb bay and engine nacelle doors, and the like) with the aid of strips arranged next to pivots or hinges (Fig.100).

Unbonded are hinged doors and covers whose area is less than 0.2 sq.m. and also doors and covers (irrespective of the area) secured with the aid of bolts or catches.

Bonding of the Tanks

The bonding of the fuel and oil tanks as well as of the tanks for hydraulic fluid is effected in the following way:

(a) in rubber tanks the bonding strips connect the metal filler necks to the aircraft structure (Fig.100a). If metal rings are fitted inside the tank, they are connected to each other and to the tank filler neck with the aid of jumpers;

(b) metal tanks have welded lugs which are connected to the aircraft structure by bonding strips.

Bonding of Pipes of Fuel-Oil-Air and Other Systems

The metal pipes of the above systems are bonded in the following manner:

(a) with the aid of metal gaskets placed in the pipe attachment blocks (Fig.100a);

(b) with the aid of clamps and jumpers;

(c) with the aid of bonding bands placed in the rubberized hose connections.

Unbonded are certain sections of the piping up to 0.5 m. long connected by means of rubberized hose and pipes used as braces in the aircraft structure.

Bonding of Equipment Units

The units of the radio and radar equipment, instrumentation and electronic equipment, instrument panels, boards, distribution boxes, and panel supports are bonded in the following way:

(a) either by connecting these items directly to the aircraft structure or to panel supports with the aid of the bolts;

(b) or by using the bonding strips fitted between the units to be bonded (Fig.100a).

Unbonded are switches, selectors, rheostats, indicating lamps and other smaller items of the control and change-over items installed on metal panels and on the aircraft structure.

Electrostatic Dischargers

The electrostatic dischargers are provided for ensuring sparkless discharge of the static electricity accumulated on the aircraft structure into the atmosphere.

The discharger is a duralumin tube, 12x10-mm dia., whose end is secured to a steel adapter and the other end is U-shaped and has an opening. Fitted inside the tube is a cotton wick showing some 30 mm from the tube; the free end of the wick is split. The wick is impregnated with a mixture of kerosene (80%) and water (20%) so that its damp end consisting of a great number of pointed ends gives away the static electricity.

The steel adaptor is screwed into the seat which is rigidly secured to the aircraft structure.

2. INTERFERENCE CAUSED BY ELECTRICAL AND RADIO EQUIPMENT AND METHODS OF INTERFERENCE SUPPRESSION

To suppress the interference caused by the electric and radio facilities do the following:

(a) try to localize the interference where it is generated;

(b) protect the receiving equipment from the interference that has penetrated the common circuits.

This is usually done by screening the interference sources and by installing de-coupling capacitors and filters.

Screening is a method of applying metal shielding to all units and wires handling the interference voltage, or units and wires where the interference voltage is induced with a view to removing the capacitive, inductive and electromagnetic effect on the receiving facilities of the radio sets.

The screens of the wires must be properly connected to the aircraft structure. The wires on the aircraft are screened by means of tinned copper shielding slipped over them and connected at its ends to the aircraft structure through the plug connectors (Fig.101).

The screens of the bunched conductors and the wires are connected to the aircraft structure with the aid of clamps having bonding padding. The transient resistance of the clamps between its lugs and the aircraft structure must not exceed 600 microohms.

If the bunch carries only several shielded wires, they must be arranged over the surface of the bunch.

When disconnecting the screened wires, be sure to finish the portions of the screen as it is shown in Fig.101 (see references 12 and 18). As a rule, the screened wires in the aircraft are disconnected as shown in assembly 12.

De-coupling capacitors. The coupling capacitors are intended for use against the interference with the view of localizing the latter where it appears. The capacitors are installed directly by the electric mechanisms producing the interference and are connected to the plus wires feeding the mechanisms. The body of every capacitor is connected to the aircraft structure.

The de-coupling capacitor is actually an infinite D.C. resistor which freely passes the A.C. of the interference over to the aircraft structure but keeps it off the plus circuit.

Radio filters. The radio filters mounted aboard the aircraft are intended for localizing the radio interference where it is produced (protective filters) as well as for suppressing the interference that has penetrated the radio facilities through the aircraft mains (suppression filters).

The filters comprise D.C. chokes and capacitors intended to handle the current of the specific frequencies only.

Chapter 3

PHOTOGRAPHIC EQUIPMENT

Photographic equipment of the aircraft includes:

1. AFA-33 type cameras marked AFA-33/100M, AFA-33/75M, AFA-33/50M for vertical and oblique photography done in daytime;

2. Camera NAFA-3c/50 for night time survey;

3. Camera SA-PL-1 for photographing the screen image of radar bombsight PBP-4.

Note: The Manufacturer does not provide the aircraft with cameras AFA-33 and NAFA-3c/50.

The location of the photographic equipment carried aboard the aircraft is shown in Fig.102.

Mount unit for day and night photography cameras is arranged in the fuselage between frames Nos 20 and 22. Automatic tilting mount AKAU-156-N for cameras AFA-33 is placed on the upper or lower row of sleeves arranged on the shaped sections of the fuselage beams. In the case of camera AFA-33/10 the tilting mount is placed on the upper sleeves, and, in the case of camera AFA-33/75M or AFA-33/50M, on the lower sleeves.

When it is imperative to install aerial cameras 4 in the aircraft for the night survey, tilting mount AKAU-156-N is removed from the lower row of sleeves and the tilting mount for camera NAFA-3a/50 is installed instead.

Camera SA-PL-1 (1) is arranged in the nose pressurized cabin between frames Nos 11 and 12.

Board 7 for controls of the camera hatch and tilting mount AKAU-156-N, camera controller KPU$_2$ (6) and camera controller KP (5) for camera NAFA-3c/50 are concentrated on the navigator's starboard console between frames Nos 2 and 3.

Camera controller KP of camera SA-PL-1 (2) is located on the operator's main control panel.

1. AERIAL CAMERAS, TYPE AFA-33M

Aerial camera AFA-33M is intended for vertical and oblique photography of the strips, areas and separate objects of army and field photographic reconnaissance, for aerial photographic survey and for photographic control of the bombing results.

Camera AFA-33M may be used at various altitudes depending on the scale of surveying.

Table 13 deals with minimum altitudes of the aircraft employment depending on the flight velocity, with the image degradation not exceeding 0.1 mm at various exposures.

Aerial camera AFA-33M is automatically controlled from the camera controller installed apart from the camera.

All mechanisms of the aerial camera are actuated and the film is taken into the camera for flattening the film by means of the drive and pressure unit mounted in the common housing.

Data Common to AFA-33M - Type Cameras

Format ..... 30x30 cm.
Number of frames in film magazine ..... 190 - 195
Length of film loaded into film magazine. 32x6000 cm.
Time of photography cycle:
at t^0 = +15 - 25°C ..... not exceeding 2 sec.
at t^0 = -6c°C ..... not exceeding 2.5 sec.
Current required at t^0 = +15 - 25°C
with electric heaters off ..... up to 13.5 A

Current consumed at t° = -60°C with
electric heaters on ..... up to 16 A
Camera controller intervals ..... 2 to 60 sec.
Voltage required ..... 26 V ±10%

Camera normal operation is ensured under the following conditions:

Vibration ..... from 10 to 80 c.p.s.
Ambient air temperature ..... from +50 to -60°C
Relative humidity ..... up to 98%
Altitude above sea level ..... up to 12,000 m.

Camera AFA-33M set carried aboard the aircraft includes: film magazine with two spools and film, camera with the objective unit, camera controller, drive and pressure unit, cardan shaft, flexible cable, electric cables, light filters, clock and automatic tilting mount AKAQV-156-H.

The weight of the set:

camera AFA-33/50M..... 105 kg
camera AFA-33/75M ..... 110 kg
camera AFA-33/100M..... 120 kg

Minimum Altitude of Survey

Flight speed, km/hr	Exposure of camera AFA-33/50M			Exposure of camera AFA-33/75M			Exposure of camera AFA-33/100M			
	1/75 sec.	1/150 sec.	1/300 sec.	1/75 sec.	1/150 sec.	1/300 sec.	1/75 sec.	1/125 sec.	1/200 sec.	
1	2	3	4	5	6	7	8	9	10	
	Altitude in metres									
250	4620	2500	1160	6900	3470	1740	9250	5680	3470	
300	5550	2750	1375	9330	4160	2360	11100	6800	4170	
350	6480	3250	1625	9720	4860	2420	13000	7950	4860	
400	7400	3700	1850	11100	5550	2780	14800	9090	5550	
450	8330	4150	2080	12500	6250	3120	16660	10230	6250	
500	9250	4625	2300	13880	6940	3470	18500	11360	6850	
550	10180	5090	2550	15280	7640	3820	20370	12500	7640	
600	11100	5550	2775	16660	8330	4160	2222C	13640	8330	
650	12030	6000	3000	18050	9030	4500	24070	14770	9030	
700	12950	6500	3250	19440	9720	4880	25950	15900	9720	
750		6900	3460		10400	5520			10500	
800		7400	3700		11100	5550			11100	
850		7850	3900		11800	5900			11800	
900		8330	4170		12500	6250			12500	
950		8780	4400		13100	6600			13200	
1000		9200	4650		13900	6950			13900	

Main Performance Data of Type A.A-33M Camera

Description	A.A-33/50M	A.A-33/75M	A.A-33/100M
Objective type	"Industar-52"	"Telemar-2"	"Telemar-7"
Objective focal length, cm.	50	75	100
Objective relative aperture	1:5	1:6.3	1:7
Angle of coverage along picture side	34°	23°	17°
Type of shutter	louvres	louvres	louvres
Exposure range, sec.	1/75; 1/150; 1/300	1/75; 1/150; 1/300	1/75; 1/125; 1/200
Shutter efficiency	Not less than 40%	Not less than 40%	Not less than 40%
Light filters .	MC-18	MC-18	MC-18
	OC-14	OC-14	OC-14
	KC-14	KC-14	KC-14

Apart from this the camera set includes:
(a) special tools;
(b) fixtures;
(c) spare parts for electric motors;
(d) electric lamps.

Components of Aerial Cameras A.A-33M

Chamber 1 (Fig.103) is a cast rectangular body whose upper portion is called easel. On both sides of the easel are arranged latches 6 which secure the film magazine to the

chamber. The right wall carries camera actuator 7, socket 13 for connecting the electric cord, seat 8 with a lamp holder to illuminate the counter, counter knob 9 intended to set the counter at zero.

The left wall of the body accommodates the following: a nozzle to connect the hose delivering air inside the camera for flattening the film, seat for the clock, and seats for the holders receiving the clock and level illuminating lamps.

Journals on the front and rear walls of the chamber attach the latter to the camera tilting mount. Besides the journals, the rear wall of the chamber is provided with a folding level for bringing the focal plane of the camera to a horizontal position. The level division runs into 60 min.

The recording instruments (level, clock and digits of the exposure counter) are illuminated by electric lamps and photographed on the film via the recording objectives.

Objective portion 10 is rigidly attached to the lower base of the chamber.

Objective portion includes the housing, objective lens, shutter, protective covers and mechanism transmitting the change speed gear motion to the shutter. The protective covers safeguard the objective lens and prevent the film from being lightstruck through the shutter lamels if they are not adjusted close to each other.

Secured on the body of the objective portion is disc with knob 12 arranged rightward for changing the exposure setting. At the bottom the objective portion is protected with cover 11.

Cameras A.A-33M are furnished with appropriate objective lenses (See Table). The objective lens surfaces are coated. The filter speed should be taken into account when the light filters are made use of.

The louvre-type shutter with the electric heaters is set inside the objective housing between the lenses. The film magazine mechanism is arranged inside the body and comprises the following units:

(a) actuator;
(b) measuring mechanism;
(c) flattening mechanism;
(d) cut-off mechanism;
(e) friction;
(f) meter;
(g) film rewinding indicator.

Actuator serves for transmitting the motion of the drive mechanism to the film magazine.

Measuring mechanism carries the motion of the actuator to the measuring roller and serves for rewinding a constant portion of film equalling the length of the picture plus intermediate area.

Flattening mechanism presses the film to the camera easel and flattens it by the flow of air at the moment of exposure.

Cut-off mechanism is intended to disengage the film magazine mechanism from the camera actuator, with the gates being closed, so as to prevent damage to the latter.

Friction serves for slipping the take-up spool as its diameter is changed while the film is being rewound and for ensuring the tight winding.

Metre indicates the amount of non-exposed film on the supply spool in metres.

Film rewinding indicator shows that the camera and film transport mechanism function properly. The film magazine is provided with mechanical and electrical indicators. The mechanical indicator is a disc whose sectors are painted white and black. The electrical indicator makes and breaks the appropriate contacts to send the current impulses to the lamp of camera controller KMV.

Camera controller KMV2 of the universal type is intended for remote control of the camera. It allows to:

(a) automatically keep the time interval between the exposures within 2 to 60 sec.;
(b) make single exposures;

(c) automatically control the bombing results;
(d) govern the camera operation by flickering of the indicating lamp;
(e) engage the air camera for continuous operation;
(f) determine the number of exposures made;
(g) engage and disengage the camera controller electric heaters.

The camera controller (Fig. 104) is shaped as a rectangular box with mechanism KMV2 mounted inside it. All controls and indicating devices are located on the front panel. Fixed in the centre of the panel is setting dial 7 with white scale 4 made throughout its circumference. Scale divisions from 2 to 60 sec. correspond to time intervals between the exposures. Division value of the scale amounts to 1 sec.

Marked between the divisions of 2 and 60 sec. is the infinity symbol (∞) for non-automatic operation controlled by the SINGLE EXPOSURE (ОДНОКРАТНАЯ СЪЕМКА) button.

Made on the cover is yellow scale 6 whose divisions correspond to the bombing altitudes. The value of every division of the scale is equal to 0.5 km.

Arranged under setting dial 7 are three buttons; central button 16 serving to start the instrument, right button 15 to stop the instrument, and left button 18 to make single exposures. To the right and left of the buttons two groups of selectors and switches are located. The camera controller is changed over to BOMBING CONTROL (КОНТРОЛЬ ПО БОМБАМ) or survey with intervals (ИНТЕРВАЛ) with the aid of selector 13. Switch 12 is engaged only if the camera must operate continuously, i.e. with the intervals between the exposures equalling the camera operation cycle.

Switch 2 is intended to turn the camera controller electric heater ON and OFF.

Selector 1 and indicating lamp 5 are not used in set with camera automatic tilting mount АКА.У-156-Н (the indicating lamp must be taken out of the lamp holder and the selector kept in the ON position).

Indicating lamp 6 lights after the instrument is energized, i.e. after pressing starting button 16 or when setting the dial at infinity (∞).

Indicating lamp 9 flickers in case of normal rewinding of the film. Besides, when selector 13 is brought to BOMBING CONTROL (КОНТРОЛЬ БОМБОМ ТАНИЯ), the lamp light indicates that the camera controller mechanism has assumed its original position and is ready for automatic bombing control.

Located to the right of setting dial 7 is exposure counter 11 (division value of the drum amounts to 5 exposures). All in all the counter shows 400 exposures. The digital drum is set at zero by rotating disc 10 in the direction indicated by the arrow.

Changeable fuse link ВП-20 is placed under cover 3.

Twelve-pin plug 14 of the camera controller is mounted on the lower wall. Set next to it is two-pin plug 17 with the two-core cord of the electric bomb release connected to it. The current impulse from the electric bomb release is supplied through this cable.

The controller is secured to the aircraft main structure with the aid of a part having a dove-tail shape. The rear wall of the camera controller is provided with a recess receiving the dove-tail.

The camera controller comprises the following main units:

(a) actuator;

(2) central mechanism for closing the starting contact;

(3) exposure counter;

(4) electric heater;

(5) valve, choke and capacitor (for reducing the radio noise).

All mechanisms of the aerial camera are set in motion and the air is delivered to the chamber portion by means of drive and pressure unit 2 (Fig.103).

Two electric motors МА-4СА are mounted inside the sleeves screwed to the body of the unit.

The camera drive electric motor operates upon receiving the current pulse sent by the camera controller in preset time intervals. Its operation lasts not more than two seconds ensuring complete operation cycle of the camera.

The electric motor of the air blower is engaged in operation simultaneously with starting of the camera controller functioning upon pressing the START (ПУСК) button. It functions as long as the air survey is performed.

Heaters. When camera АФА-33М operates under subzero temperatures within a range of -15°C to -60°C, the electric heater of camera controller КПУ$_2$ should be switched on through switch 2 (Fig.104). Electric heaters of the clock and shutter are switched automatically through the thermoregulator when the temperature keeps within +3°C to +13°C.

Tilting Mount АКАУ-156-Н

Tilting mount АКАУ-156-Н (Fig.103) is intended for mounting aerial camera АФА-33М in the aircraft and for reducing the vibration.

The camera mount unit is located in the central part of the fuselage between frames Nos 20 and 22 where two rows of cast sleeves 15 are set on the profiles of the landing gear beams to install the tilting mount with the aid of spring-loaded shock absorbers. The tilting mount is made up of three frames hinged together.

Frame 20 is fixed rigidly; four spring-loaded shock absorbers and setting screws are provided in its corners for levelling the tilting mount.

Note: When the tilting mount is used for aerial camera АФА-33/100М, spring-loaded shock absorbers 16 marked (on the cover) F = 1000 mm are installed; for aerial cameras АФА-33/75М or АФА-33/50М use shock absorbers marked F = 750 mm.

Electric mechanism MVS-2 (19) is fixed to the frame starboard portion. Its rated voltage is 26 V ±10%, rated torque equals 100 kg-cm. and rated current consumed under rated load is 8.5 A.

The output shaft of the electric mechanism carries bevel gear wheel 18 engaged with gear 57 on the axle of cam shaft 56.

The cam shaft is provided with seven cams 49, 50, 51, 52, 53, 54, 55 with seven microswitches BK-1-140 arranged against the cams on the frame panel. Cam 55 serves for blocking the bombing control mode of operation. Cams 54, 53, 52, 51, 50 are used for fixing frame 27 in 0°, 15°, 10°, 20° and 25° positions. Cam 49 engages the tilting mount for reverse run after setting it at 0°.

Besides, the shaft is furnished with two spur gears 48 meshed with toothed quadrants 40 fixed to middle frame 27.

When electric mechanism 19 starts operating, gear wheels 48 rotate to shift quadrants 40 thereby turning frame 27 together with inner frame 29 and aerial camera around semi-axles 21. The aerial camera will be tilted only backwards through angles 0°, 10°, 15°, 20°, 25° and stop in any of the above positions depending on the desired angle at which the angle-of-tilt selector on the tilting mount control panel is set.

At this setting the camera performs one-strip oblique survey (except when set at 0°). This mode of the tilting mount operation is called BOMBING CONTROL. It engages cameras AFA-33/100M, AFA-33/75M and AFA-33/50M.

Frame 29 serves for attaching the aerial camera and for performing the two-strip photography.

The journals of cameras AFA-33M are set in the sockets where hinged covers 24 lock them. In its turn the cover is secured with the aid of hinged clamp 25 with stop 26. Besides, the journals are additionally secured with locking screw 22 with a view to obviating the possible play.

Provided in the front part of the frame is locking screw 41 with a spherical washer securing the bracket of the aerial

camera journal. The rear wall of the frame has bracket-plate 23 for mounting the drive and pressure unit.

Socket 30 is provided for connecting the power source to the camera controller when checking the tilting mount functioning on the test-stand or on the ground. Button 31 sends pulses to relay RP-2 when starting the inner frame to move from the extreme positions and when checking the tilting mount functioning in the AERIAL RECONNAISSANCE (РАЗВЕДКА) mode of operation with the aerial camera removed.

Located on the left side (looking forward) of the lower portion of frame 29 is split box 43 accommodating the following:

(1) relay RP-2 for starting the frame to move from the extreme positions;

(2) relay MP-2 of the reverse movement;

(3) relay K25A of the angle-of-tilt mechanism;

(4) relay K24A of the tilting mount mechanism;

(5) split receptacle.

Located above the box is electric mechanism MVS-2 (28) which serves for turning frame 29 with the aerial camera around semi-axles 42 to the port or starboard side. In this instance the aerial camera performs two-strip oblique photography in the extreme positions. This mode of the tilting mount functioning is called AERIAL RECONNAISSANCE (РАЗВЕДКА).

The output shaft of electric mechanism 28 carries spur gear wheel 28 which is engaged with gear wheel 39 fitted onto cam shaft 32. Microswitch BK-1-140 is set on panel 33 against cams 34. Microswitch 35 disconnects the electric mechanism when frame 29 assumes its extreme positions. Microswitch 36 operates when the tilting mount comes to the zero position; it cuts off the current supply via relay RP-2 and simultaneously cuts in the indicating lamp on the photographic equipment panel. Microswitch 37 is used for blocking the RECONNAISSANCE mode of operation.

The inner frame is tilted in the AERIAL RECONNAISSANCE mode of operation with the aid of link mechanism comprising roll-crank 47, slider 46 and dovetail 44. This mechanism is

also used for changing the frame tilting angle from 6°30' to 8°30' or vice versa, which is done by resetting slider 46 relative to dovetail 44 and fixing it for the desired operation modes with the aid of screw 45.

The proper setting of the air camera is checked in the BOMBING CONTROL and AERIAL RECONNAISSANCE modes of operation with the aid of level brought to its sides.

Note: The frame is departed from the vertical through 6°30' when placing air camera AFA-33/100M on the tilting mount, and through 8°30' when placing camera AFA-33/75M. Air camera AFA-33/50M is not used in the AERIAL RECONNAISSANCE mode of operation, as the edges of the camera hatch cut the field of vision of the camera when the latter is tilted to the board side.

The tilting mount is governed from the photographic equipment control panel (Fig.105) arranged on the navigator's starboard console.

Switch 3 (Fig.105) controls opening and closing of the camera hatch doors. When the camera hatch doors are open, the green indicating lamp lights up.

If the camera window doors are closed, the camera and tilting mount do not function.

Functioning of Camera Mount Unit

Survey with preset intervals. Setting dial 7 of the camera controller (Fig.104) should be brought to the preset interval (5 - 7 sec.), and selector 13 to position INTERVAL (ИНТЕРВАЛ). Starting button 18 is pressed to apply voltage to the camera controller electric motor, aerial camera and drive-and-pressure unit. The air blower starts delivering the compressed air to the camera and at the moments of exposure the film will be pressed to the platen of the film magazine.

The camera controller sends current pulses to the electric motor actuator of the camera. The motion of the aerial camera is transmitted to the film magazine with the aid of the actuator head, and the film starts immediately rewinding (beginning of the camera operation cycle), the platen comes down to the camera casel, the pressure of the air in the camera goes up to press the film to the platen. Simultaneously the shutter in the camera objective lens gets wound and the objective cover gets opened.

As the shutter operates, the contacts in the chamber engaging the recording instrument lamps (clock, level and counter) whose indications are recorded on the film get closed.

After functioning of the shutter the contact-pulse mechanism of the chamber gets closed to send pulses to tilting mount AKAZH, and if the latter is set at AERIAL RECONNAISSANCE (РАЗВЕДКА), electric mechanism 28 (Fig.103) will operate and the camera will come from one extreme position to the other. At the same time the film magazine platen comes up to set the film free so that the take-up spool will draw the film from the supply spool.

As the film is being rewound, the mechanical and electrical indicators in the film magazine operate. The mechanical indicator operates upon rotation of the indication drum arranged on the semi-axle of the supply spool, the electrical indicator showing the film rewinding by short flickers of lamp 9 (Fig.104) of the camera controller marked REWINDING (ПЕРЕМОТКА).

The camera operation cycle comes to its end when the platen in the film magazine has assumed its uppermost position and the indicator on the driving axle of the film magazine has come against FREE (СВОБОДНО). In this position the gate may be closed and the film magazine removed.

Single exposures and continuous operation. For making the single exposures setting dial 7 (Fig.104) should be brought to infinity (∞), after which indicating lamp 6

marked CURRENT ON (ТОК ВКЛЮЧЕН) lights to show that the system is energized.

Single exposure requires that SINGLE EXPOSURE (ОДНОКРАТНЫЙ СНИМОК) button 18 should be pressed. In this instance the camera makes one exposure and stops. The operation cycle is repeated upon pressing the button again.

The camera is changed over for continuous operation with the aid of switch 12 of the camera controller. The setting dial must be brought to infinity (∞), and selector 13, to INTERVAL (ИНТЕРВАЛ).

Photographic control of bombing results. For the automatic control of the bombing results the electric bomb release cord should be connected to the camera controller and the bomb release button.

The yellow triangular index of setting dial 7 (Fig.104) should be brought against the desired altitude on yellow altitude scale 8. Selector 13 should be set at BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ). Directly before releasing the bombs the camera controller should be cut in by pressing START (ПУСК) button 16 which is followed by lighting of red indicating lamp 6 labelled CURRENT ON (ТОК ВКЛЮЧЕН) and green indicating lamp 9 labelled READY FOR BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОМЕТАНИЯ). The camera controller motor starts operating. Lamp 9 goes out as the bomb release button is pressed (0.2 to 0.3 sec. long). In a period of time depending upon the preset altitude, i.e. 10 sec. before the burst of the bomb, the camera electric motor starts operating and functions continuously as long as 25 sec.; lamp 9 flickers to indicate that the film is being rewound properly. In 25 sec. lamp 9 stops flickering and lights again to show that the system has assumed its original position READY FOR BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОМЕТАНИЯ).

During 25 sec. of continuous operation camera AFA-33M makes 11 - 13 exposures; 5 or 6 of them made before the burst of the bomb and 6 or 7 exposures after.

During the next survey approach the photography is done in the same sequence.

Camera Hatch

Made in the fuselage skin between frames Nos 20 and 22 is camera hatch (Fig.106) sizing 450x560 mm with remote control from the navigator's panel of photographic equipment (Fig.105).

Electric mechanism УР-7М (1) actuates doors 17 (Fig.106) to draw inside the fuselage along guides 14 and 16 with the aid of linkage.

Electric mechanism УР-7М operates to impart motion to driving shaft 2 on the opposite end of which driving pulley 12 with steel bands 13 looped over it is mounted to transmit rotation to the pulley of the driven shaft. Turnbuckles 11 connect bell-cranks 10 to the camera hatch doors. Driving shaft 2 carries four cams 4 and two protective limiters 9 which safeguard box 3 with the microswitches against damage.

Microswitch 5 serves for disengaging electric mechanism УР-7М when the camera hatch doors are open and for applying voltage to the indicating lamp on the photographic equipment panel labelled САМЕРА ЛЮК ОТКРЫТ (ЛЮК ОТКРЫТ). Microswitch 6 disconnects the electric mechanism feed when the camera hatch is open. Microswitch 7 is intended to interlock the controller of camera НА А-3с/50, and microswitch 8 is intended to interlock the controller of camera А.А-33М.

2. АЕРІАЛ САМЕРА НА А-3с/50

Aerial camera НА А-3с/50 (Fig.107) is intended for night photography. It can be used for single exposures and short-strip survey. The aerial camera is an automatic device remotely governed from the camera controller. The exposure is made automatically by the flare of photoflash bomb. The camera mechanism is actuated by electric motor МА-40А.

Main Data of Camera HA.A-3c/50.

Objective	Industar-52
Objective lens focal length	50 cm.
Objective lens relative aperture	1:5
Camera field-of-vision angle:	
along picture longer side of 24 cm.	27°
along picture shorter side of 18 cm.	20°
along diagonal	34°
Picture size	18x24 cm.
Number of pictures	150
Type of shutter	louvres
Exposure in seconds	1/25, 1/50, 1/100
Shutter efficiency:	
for 1/25-sec. exposure	not less than 50%
for 1/100-sec. exposure	not less than 45%
Shutter lag	not more than 1/60 sec.
Current consumed, at 26 V and t° within +10 to +30°C	not more than 12 A
Current consumed, at 26 V and t° = -60°C	not more than 13.5 A
Time of operation cycle at 26 V in the mains and t° = +10°C to +30°C	not more than 3 sec.
Camera, film magazine, camera controller and converter function at an ambient air temperature of	+50°C to -60°C
Automatic release operates at an ambient temperature	+35°C to -60°C
Shutter operates under illumination intensity of automatic release photocell	2 to 15 lux
Operating voltage of camera HAOA-3c/50	26 V ±10%
Camera mount unit ensures survey at angles	from 0° to 25° with intervals of 2°30'

The flight set of camera HAOA-3c/50 includes: film magazine with two spools and film, chamber with the cone, objective shutter and electric motor MA-40A, camera controller, automatic release AC, converter PV-45A, camera mount unit and electric cords.

The weight of the flight set runs to 46 kg.

In addition to the above the delivery camera set includes: (a) special tools; (b) various fixtures; (c) spare parts for electric motor, automatic release and converter.

Aerial camera is located in the fuselage between frames Nos 20 and 22.

When camera HAOA-3c/50 is employed, tilting mount AKA$V-156-N should be removed and the appropriate tilting mount installed in the lower row of sleeves instead.

Description of Components of Camera HA.A-3c/50

Film magazine 3 (Fig.108) is an autonomous part of the aerial camera intended for arranging, rewinding, measuring the aerial film and for protecting it against light-striking. The film magazine accommodates 37-m. length of film, 19 cm. wide.

The film magazine consists of a case and mechanism. The upper surface of the case bears arrow 5 showing the position of the camera relative to the aircraft attitude. Celluloid plate 4 is secured to the upper surface of the case, too, for writing entries.

Gate 6 in the base of the film magazine case protects the film against being light-struck when the film magazine is removed from the chamber portion.

The film magazine mechanism comprises three main units:

(1) rewinding mechanism;

(2) measuring mechanism which serves for measuring required amount of film equalling the length of frame plus intermediate area;

(3) mechanism flattening the film at the moment of exposure.

Chamber portion 2 of aerial camera is a cast rectangular body with objective-lens-bearing housing attached to its lower portion, and flattening glass plate with the latch in the upper portion for securing the film magazine to the chamber. The rear wall of the chamber has a hole with a threaded plug which receives the crank for testing the camera operation. The chamber portion accommodates mechanism consisting of (a) dynamic brake relay meant for speedily braking the electric motor axle and all the mechanism of the chamber portion after discontinuing the power supply to the electric motor; (b) transmission mechanism intended for imparting the motion to the shutter, film magazine and counter; the latter serves for recording three-digit number of the picture.

Cone 17 is intended for securing the objective housing with the shutter. Three brackets 14 are attached to the cone for setting the aerial camera in the camera mount unit.

Shade 6 with the protective cover is put on the cone with the view of safeguarding the shutter and objective against damage and of limiting the side rays of light. Exposure setting knob 15 is secured on the outer surface of the cone shade.

A louvre-type shutter is mounted between the objective lenses. The shutter mechanism comprises the actuator, the operating gear consisting of lamels and pinions, exposure setting mechanism and releaser mechanism.

Automatic releaser 18 is provided for sending the current pulses to the shutter electromagnet when the photoflash bomb explodes.

Photocell ИТ-1 is cesium, gas-filled. Amplifier tube 6П6С is intended to amplify the photoflux whose intensity is too weak. After that the amplified current is directed to the shutter electromagnet which in turn ensures operation of the shutter.

Converter РУ-45А (1) is designed for converting the low voltage across the aircraft mains to high voltage necessary for the operation of the amplifier tube and photocell.

Camera controller (Fig.108) serves for remote governing camera НАФА-3с/50.

Housing 7 accommodates common switch 1, indicating lamp 2 labelled REWINDING (НАПЕРЕТКА), indicating lamp 3 labelled CURRENT ON (ТОК ВКЛЮЧЕН), indicating lamp 4 labelled ILLUMINATION (ПОДСВЕТКА), starting button 5 labelled CHECK-UP (ПРОВЕРКА), heater switch 6 and connector plug 8. Common switch consists of two switches having one common handle.

When the operation is over, the common switch should be set to OFF (ВЫКЛЮЧЕНО). One of the switches disconnects the night photography circuit, the other switch cuts in the camera electric motor circuit so that the camera should complete half of its cycle before the film magazine platen has assumed its uppermost position.

When common switch 1 is "ON" the aerial camera electric circuit is closed and the camera is prepared for operation. Indicating lamp 3 labelled CURRENT ON (ТОК ВКЛЮЧЕН) lights up.

As the film is being rewound in the process of the camera operation, REWINDING (НАПЕРЕТКА) indicating lamp 5 flickers. CHECK-UP (ПРОВЕРКА) button 5 serves for checking the aerial camera operation.

Heater switch 6 serves for engaging the shutter heater into operation.

Mount Unit for Camera НАФА-3с/50

The mount unit serves for setting the aerial camera at angles of 0°, 2.5°, 5°, 7.5°, 10°, 12.5°, 15°, 17.5°, 20°, 22.5° and 25° relative to a vertical plane opposite to the flight direction and for reducing the effect of the aircraft vibrations on the quality of the pictures.

Mounted on the outer frame of the mount unit (Fig.107) are four spring-loaded absorbers 11 intended for arranging the camera mount unit in the sleeves attached to the aircraft main structure. Inner frame 9 is connected to outer frame 12 with the aid of semi-axles 13.

The tilt of the inner frame is fixed with the aid of spring-loaded catch 8 which enters the hole of sector 7 located on the outer frame.

The camera is turned and set at required angle before the flight depending on the mission assigned to the aircraft.

Inner frame 9 has four lugs. Two of them are slotted to receive the bolts of the aerial camera brackets with the aid of which the aerial camera is secured to the mount unit.

The automatic releaser is secured to the suspension bracket with the aid of the dovetail; converter PV-45A is installed on special platform of the outer frame. All members of the aerial camera are connected by means of electric cords equipped with plugs and sockets.

Functioning of Air Camera HA-3c/50

After setting common switch 1 (See Fig.108) into ON (ВКЛЮЧЕНО) position the indicating lamp marked CURRENT ON (ТОК ВКЛЮЧЕН) lights on the camera controller showing that the voltage is supplied to the filament of the amplifier tube in automatic releaser and converter PV-45A is engaged into operation. At the same time the aerial camera electric motor receives power and starts rotating, thereby imparting motion to the mechanisms of the film magazine, shutter and counter. The measuring rollers of the film magazine rewind half the picture and get disengaged.

While the film is being rewound, the REWINDING (ПЕРЕМОТКА) indicating lamp on the camera controller flickers. The film having been rewound, the film magazine platen lowers down on the glass plate of the chamber portion of the shutter and the successive digit designating the picture springs in the counter.

As soon as it happens the electric motor and all mechanisms of the camera chamber portion, film magazine and shutter stop immediately. In this position the aerial camera is ready for operation.

The operation cycle of the aerial camera is performed as follows:

(1) exposure (beginning of the cycle);
(2) rising of the film magazine platen;
(3) beginning of the film rewinding procers;
(4) termination of the film rewinding process;
(5) closest pressure of the platen;
(6) breaking of the interlooking contacts (termination of the cycle).

When the photocell is illuminated by the flare of the photoflash bomb, its circuit induces current which is then amplified by the amplifier tube and sent to the shutter releaser elcotromagnet. The armature of the releaser electromagnet draws itself to the core actuating the camera shutter to operate. The film is being exposed and the counter digits are photographed on the film. Then the camera electric motor is engaged in operation rising the platen, rewinding the film and lowering the platen. All this done, the motor comes to standstill.

Installation of Camera HA-3c/50

The aerial camera is installed in the fuselage between frames Nos 20 and 22 on the lower row of cast sleeves provided on the profiles of the landing gear fore-and-aft beams placed at 210 mm below the upper row of sleeves. The mount unit is secured to the sleeves by means of union nuts 10, and the aerial camera is placed on the inner frame and fixed with the bolts fitted on the camera.

Automatic releaser A.C. is secured to suspension bracket 20 by means of dovetail, the automatic releaser circular aperture facing the camera hatch hole. The dovetail serves for attaching converter PV-45A on the platform of the camera mount unit outer frame. Camera controller KH is mounted on the navigator's panel by means of a dovetail, too. In this instance the platform for the dovetail used for

mounting camera controller КПУ2 is removed and a dovetail for the controller of camera НАФА-3с/50 is fixed in its place.

3. AERIAL CAMERA ФА-РП-1

Camera ФА-РП-1 is automatic and remotely controlled. It is designed for photographing the image of the cathode-ray tube screen of radar bombsight РБП-4 while performing sector and circular scanning.

Main Data

Operating voltage of camera	26 V ±10%
Type of objective	Uran-10
Objective lens focal length	10 cm.
Objective relative aperture	1:2.5
Diaphragm	iris
Picture size and shape	circular, 13-cm. dia.
Film dimensions:	
width	19 cm.
length	2850 cm.
Number of pictures taken without reloading film magazine	200
Operation cycle	in every 2, 5, 10, 20 revolutions of antenna or sector scan
Current consumed:	
with heater OFF	5.3 A
with heater ON	15.6 A
Temperature range of operation	from +50°C to -60°C
Relative humidity	up to 98%

The flight set of camera ФА-РП-1 includes the chamber with cone, objective and silica gel cell, film magazine with two spools and film (two lengths), camera controller, electric cards, casing, camera mount unit, sight, clock.

The flight weight of the set amounts to 30 kg.

Units of Camera ФА-РП-1

Chamber 13 (Fig.109) serves as a connecting link between the cone and the film magazine.

Located in the upper portion of the body is the focal plane of the camera which is a rectangular window glazed with flattening glass. Film magazine 14 is attached to the upper part of the chamber.

Silica gel cells are provided in the rear part of the chamber portion. In the left part of the chamber body, located under the cover, is the change speed mechanism whose motion is imparted to the film rewinding mechanism, exposure counter, distributing roller governing the lifting of the platen and closing the contacts.

Knob 17 serves for checking the manual operation of the camera which functions exactly as it does when driven by the electric motor.

Arranged on the left part of the chamber are eight-pin plug 24 and potentiometer knob 23 intended for changing the illumination intensity of the recording instruments as required by sensitivity of the film employed for survey.

Electric motor МА-40А, plug and socket connector, dynamic brake relay of the electric motor armature, clock and exposure counter which are projected on the film with the aid of special objective are placed on the front wall of the body under cover 12.

Two spiral heaters of the chamber and the heater of the film mechanism in the box are accommodated inside the chamber body. The electric heaters are cut in by means of the thermo-

regulator when the temperature inside the chamber is 8 ±5°C.

Cone. One end of the cone is secured to the chamber portion. The other end of the cone is attached to the jacket with indicator 1 of radar bombsight РБП-4 secured to it by means of clamp 2.

The jacket is provided with sight 27 which enables the operator to observe the indicator screen during the survey. The right part of the sight is made "blind" so that the observation is carried out by one eye only. The jacket is provided with outer casing which is turned to align the oval ports of the inner jacket and outer casing through which the indicator screen is accessible for cleaning and the shutter can be opened manually for focusing the camera. The focusing is accomplished with the aid of rings 5 turned in a vertical plane over the threaded portion of the cone body.

The shutter accommodated above the camera objective is opened by means of special electromagnet. When the camera is being focused, the shutter is opened by hand with the aid of special lever. The manual shutter opening mechanism is accommodated outside the objective, the lever being accessible through the oval ports in the jacket. The diaphragm setting lever is arranged there, too. When the shutter is fully open, the appropriate contact gets closed to make the circuit of the camera controller indicating lamp 5 (Fig.110) marked SHUTTER (ЗАТВОР), after which the lamp lights up and keeps on while the shutter is open.

Film magazine is intended for rewinding, measuring, flattening the film when it is being exposed, and for protecting it against being light-stricken.

Film magazine 14 (Fig.109) is made up of the base to which side pieces are attached for mounting the rewinding mechanism and the cover. The left side wall of the film magazine carries the output end of driving shaft of the film rewinding mechanism and disc 15 of the mechanical indicator; placed under jacket 16 are the four-pin plug connecting the film magazine electric circuit with the chamber and the push-

[illegible] actuating the platen raising lever. The right side wall [illegible]nts movable semi-axles of the spools, the meter of the non-[illegible]posed film and the film magazine carrying belt being arranged [illegible] the centre of the side wall. The film magazine mechanism [illegible]ounted inside the film magazine comprises the following main [illegible]nits:

(a) rewinding mechanism;

(b) flattening mechanism of the film magazine which serves for flattening the film;

(c) friction mechanism arranged on the take-up spool and intended for slipping the supply spool;

(d) film rewinding indicator which shows that the camera and rewinding mechanism function properly; the film magazine is provided with electrical and mechanical indicators;

(e) meter showing the amount of the non-exposed film left; the meter scale is marked in metres.

The inner part of the film magazine carries two box-shaped electric heaters; besides, the electric heaters are fixed in the metering and guiding rollers.

The inner surface of the film magazine is lined with sheet cork for reducing the heat loss.

Camera Controller

Camera controller (Fig.110) serves for remote control of camera АА-РП-1 operating in conjunction with radar bombsight РБП-4.

The camera controller allows to:

(a) engage and disengage the aerial camera;

(b) take pictures at desired frequency (every 2, 5, 10 and 20 revolutions of the antenna);

(c) carry out survey under sector and circular scanning modes of operation;

(d) perform single exposures;

(e) govern the functioning of the camera by the indicating lamps;

(f) show the number of the exposures made.

Arranged in the right part is exposure counter drum 8 with a division value of five exposures. The digital drum is illuminated from the inside. It is set at zero by means of disc 7.

Three indicating lamps are set above it. Red indicating lamp 6 lights when the common switch is brought to the ON (ВКЛЮЧЕНО) position. The green indicating lamp shows that the film magazine functions properly; it flickers when the film is being rewound in the film magazine. Yellow indicating lamp 5 lights up brightly when the shutter is open all the way out. When packet-type switch 14 is changed over to SINGLE EXPOSURE (ОДИНОЧНЫЙ), lamp 5 periodically goes out and lights up at half glow. To get a good picture press the button when lamp 5 has gone out.

In the left part there is a plate for making entries. The lower portion of the camera controller is provided with four sockets. Socket 12 marked "MAINS 26 V" (СЕТЬ 26 В) supplies power to the whole camera controller; socket 13 for an eight-pin plug marked CAMERA (КАМЕРА) receives the electric cord connecting the camera controller with the camera; four-pin plug 15 marked RADAR (РАДИОЛОКАТОР) supplies pulses from the antenna circular scanning mechanism of radar bombsight РБП-4 and pulses from the sector scanning antenna relay. Plug 16 is not used here. The rear wall of the camera controller is furnished with a dovetail for attaching the camera controller to the aircraft main structure.

The principal mechanism of the camera controller is a camloaded relay which is an electro-magnet device converting the current pulses coming from the antenna unit of radar bombsight РБП-4 into mechanical travel of the cams closing the contacts that send the pulses to the shutter and electric motor of the camera.

To make the operation of the camera controller units more reliable, the camera is provided with an electric heater which is cut in automatically by means of the thermoregulator

at an ambient temperature of +8°C ±5°C and cut out when the temperature comes to +25°C ±5°C.

Camera Mount Unit

The camera mount unit (Fig.109) is used for carrying the aerial camera and the indicator of radar bombsight РБП-4. The mount unit comprises the lower fixed frame which in turn is made up of two brackets 8 and 11. One end of the lower frame is secured to the profile of the operator's console holder by means of the support, and the other end, to the operator's central panel holder.

Sleeves 20 of the fixed portion of the camera mount unit receive movable frame consisting of two posts 22, guiding pipes 28 and base 9 with spring-loaded shock absorbers 18 on which the aerial camera is mounted.

Shock absorbers 18 are held to sleeves 20 by union nuts 19.

To reduce the vibration of the camera mount unit during the take-off and landing, the frame together with the camera mounted on it is braced with the aid of three spiral springs 4. The indicator of radar bombsight РБП-4 is attached to the movable jacket by its upper part and to the pipe of post 28 with the aid of bracket 29. The camera mount unit is removed and installed together with the camera but without the film magazine. To avoid breaking of the shock-absorber springs during the aircraft landing, the bottoms of sleeves 20 are lined with felt pads.

The camera and camera controller are connected by means of a number of length of electric cord. Besides, special cords connect the camera controller with the aircraft mains and the antenna equipment of radar bombsight РБП-4. The plug of the first (power) cord is connected to the socket of the camera controller, the other end of it provided with a plug, too, is joined to the aircraft mains and engraved MAINS (СЕТЬ).

The thicker pin should be connected to the plus. If this condition is not observed, the electrolytic capacitor unit will fail.

The other electric cord - the one of the radar - serves for connecting the camera controller with the antenna equipment. One end of this cord is connected to the plug marked RADAR (РАДИОЛОКАТОР) on the camera controller, and the other, split end, to the antenna microswitch for the circular scanning mode of operation and to the reversing relay of the antenna operating for sector scanning. The third cord connects the camera to the camera controller.

Mount Unit of Camera ФА-РД-1

The mount unit for camera ФА-РД-1 is installed in the fuselage between frames Nos 11 and 12 and secured to the operator's starboard console holder and to the operator's panel holder arranged on frame No.12.

For removing the mount unit take out four locking pins 6 (Fig.109) and withdraw the whole mount unit together with the camera. The camera controller is mounted on a special beam whose lower portion is secured to the holder of the operator's main panel.

4. ELECTRICAL SYSTEM OF PHOTOGRAPHIC EQUIPMENT

The electrical system of the photographic equipment performs the following duties:

(1) it governs the functioning of the camera hatch doors;

(2) it changes the tilting camera mount middle frame over to the angles of 0, 10°, 15°, 20° or 25° in the direction opposite the flight in the BOMBING CONTROL mode of operation;

(3) it sets the tilting mount inner frame at angles of $6^{\circ}30'$ or $8^{\circ}30'$ (depending on the camera mounted) right and

left of the aircraft axis in the AERIAL RECONNAISSANCE mode of operation;

(4) it supplies power to aerial cameras АФА-33М, НАФА-3с/50 and ФА-РД-1.

Camera Hatch Door Control

The camera hatch doors are brought to the required position with the aid of selector 3. For this purpose one of contacts 27 or 28 is energized to supply power to electric mechanism УР-7М which governs the functioning of the camera hatch doors. When the doors come to their extreme positions, microswitches 14 and 15 function to break the feed circuits of the contactors.

When the doors are in the open position, the microswitch not only de-energizes the appropriate contactor but also feeds the following:

(1) lamp 2 indicating the open position of the camera hatch doors;

(2) selector 4 marked BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) - AERIAL RECONNAISSANCE (РАЗВЕДКА), thus interlocking the tilting mount not to be operated when the camera hatch doors are closed.

Electric mechanism УР-7М is D.C. two-pole, series-wound, reversible electric motor 40 intended to impart rotation to the output shaft through the worm gear and two-stage planetary reducing gear 39. Electromagnetic clutch 41 provided in the electric motor is mounted with a view to reducing the run-out of the output shaft and for engaging the electric motor shaft with the reducing gear.

Performance Date of Electric Mechanism УР-7М

Rated operating voltage ..... 24 V
Rated shaft torque ..... 1.77 kg/cm.
Rated current ..... 7.9 A

Intermittent mode of operation ..... 1 min. of operation under rated load and 10 min. of interval within a scope of 3 cycles. The above can be repeated after complete cooling down

When the camera hatch doors are open, limit switches 12 and 13 connected to the cables of the bunch between the camera and the camera controller operate, too. Those switches are intended to start the functioning of aerial cameras AFA-33M and HAFA-3c/50 only when the camera hatch doors are open all the way out as they break the feed of the aerial camera chamber electric motors.

Functioning in the BOMBING CONTROL Mode of Operation

Selector 4 should be brought to the desired position whenever necessity comes to prepare the system for BOMBING CONTROL mode of operation. If in this instance the inner frame of the camera tilting mount is out of the zero position, the voltage should be first applied to contactor 18 of electric mechanism MVO-2 (29) by means of switch 22; the electric mechanism sets the inner frame to the zero position.

Only in this position of the inner frame will the power supplied by selector 4 via pressed down switch 22 reach button 7 and relay 8 which govern the functioning of electric mechanism MVO-2 (37) of the camera tilting mount middle frame.

The middle frame may be set at a certain angle in two cases, i.e. when the frame setting requires that a greater tilting angle should be changed over to a smaller one, or vice versa.

In the first case (i.e. when a greater tilting angle is changed over to a smaller one), selector 9 should be brought

to indicate the required angle, and then button 7 pressed. As a result, relay PP-2 (8) functions so that its contacts interlock button 7 thus ensuring automatic operation of the circuit. The power is supplied via contacts of button 7 and the contacts of relay 8 to selector 9 whence it is directed to the winding of contactor 10 by means of the appropriate limit switch (31, 32, 33, 34, 35).

Contactor 10 gets engaged to make the supply circuit of mechanism MVO-2 (37) which inclines the tilting mount through the appropriate angle. When the tilting mount reaches the angle, special cam provided on the shaft and geared with the electric mechanism will press the appropriate limit switch set for the desired angle.

As a result:

(1) the supply circuit of contactor 10 and the electric mechanism is de-energized, i.e. the middle frame of the tilting mount stops;

(2) the circuit of indicating lamp 6 is closed.

Relay PP-2 (8) will be energized till selector 9 is switched to another angle or till selector 4 is brought to AERIAL RECONNAISSANCE (РАЗВЕДКА).

In the second case (i.e. when the tilting angle is increased) the middle frame of the tilting mount should be first raised to zero position. For this purpose selector 9 should be brought to zero and button 7 pressed. As a result, the system functions as described above and the middle frame of the tilting mount assumes the zero position. Then selector 9 is brought to the required angle and then button 7 pressed. It involves engagement of contactor 10 which supplies power to electric mechanism MVO-2 (37). The latter raises the frame 1° above the zero position, which will press limit switch 23. This switch delivers voltage to the winding of relay MP-2 (36) which operates to reverse electric mechanism MVO-2 (37), its contacts closing its own supply circuit. Electric mechanism 37 lowers the middle frame to the required angle. At the same time special cam provided on the shaft and

geared with the electric mechanism presses the respective limit switch (31, 32, 33, 34, 35) set for the required angle.

As a result:

1. Supply circuit of contactor 10 gets broken thus de-energizing the electric mechanism, i.e. the frame comes to standstill.
2. Relay 36 gets de-energized.
3. The circuit of indicating lamp 6 gets closed.

Note: After contactor 10 has been de-energized, relay 36 retains current for a while as its winding is fed with the back e.m.f. provided by the electric motor of mechanism MVÐ-2 (37) rotated due to inertia.

This phenomenon is liable to disengage the toothed sectors of the middle frame from the toothed wheels of the shaft. Limit switch 45 is provided to obviate such a trouble. This switch is preset for 26.5° angle and connected to the minus circuit of relay 36.

In case the middle frame has tilted through more than 25°, switch 45 is pressed, thus breaking the minus circuit of relay 36. This de-energizes relay 36 and breaks the supply circuit of electric mechanism MVÐ-2 (37) engaged in increasing the frame tilting angles; at the same time the supply circuit gets closed to engage the mechanism in decreasing the tilting angles. Therefore, the mechanism brings the frame to the required angle and stops.

Electric mechanism MVÐ-2 is D.C., two-pole, reversible, series-wound electric motor 43.

Main Data of Electric Mechanism MVÐ-2

Operating voltage range ..... from 24.3 to 29.7 V

Shaft torque:

rated ..... 100 kg/cm.

maximum ..... 120 kg/cm.

Current consumed:

at rated shaft torque ..... not exceeding 8.5 A

at maximum shaft torque ..... not exceeding 10 A

Intermittent mode of operation:

for one-side rotation ..... 1.5-sec. operation period and 1-sec. interval (200 engagements)

for two-side rotation:

right ..... 30-sec. operation period and 3-sec. interval

left ..... 30-sec. operation period (10 cycles)

The electric mechanism may be engaged in the same operation mode after a one-hour lapse of time.

System Engaged in AERIAL RECONNAISSANCE Mode of Operation

Preparation of the whole system for AERIAL RECONNAISSANCE mode of operation requires that the selector 4 should be brought to the respective position. If the middle frame of the tilting mount is not in the zero position, the current from selector 4 will pass to contactor 10 of electric mechanism 37 through the normally closed contacts of limit switch 30. Electric mechanism 37 is energized to raise the middle frame to the zero position. The frame comes to the zero position thereby pressing limit switch 30 so that the current from selector 4 will reach contactor 18 through the normally open contacts of switch 30. As a result, electric mechanism MVÐ-2 (29) starts operating to bring the inner frame to a tilted position and then gets disconnected as special cam provided on the shaft and geared with electric mechanism MVÐ-2 (29) presses limit switch 19. The inner frames will be left in this position until aerial camera AOA-33M makes an exposure.

While making an exposure the aerial camera sends a pulse reaching relay 21 through cable ЖК-14. Relay 21 operates to close the supply circuit of contactor 18 and its own supply circuit via the normally closed contacts of limit switch 20.

Electric mechanism МУФ-2 (29) starts operating to bring the inner frame from one extreme position to the other. When the frame passes by the zero position, limit switch 20 operates to make the circuit of indicating lamp 5 and to break the supply circuit of relay 21. But contactor 18 remains engaged, as its winding is fed through the parallel-connected circuit via limit switch 19 and electric mechanism 29 goes on driving the inner frame to the other extreme position. Once the frame has reached the extreme position, limit switch 19 operates to break the current supply of contactor 18. The electric mechanism stops the frame and holds it in the position until the camera sends another pulse.

Electric mechanism 29 operates in one direction all the time, the frame being brought from one extreme tilted position to the other by means of a crank mechanism.

Button 16 may be employed for sending an artificial pulse to relay 21 thereby providing a check-up of the circuit operation for aerial reconnaissance without engaging the aerial camera.

Power Supply

Controllers of aerial cameras АФА-33М and НАФА-3с/50 are supplied with current through socket 48К (11) installed on the navigator's starboard console. If the serviceability of these cameras must be checked without using the aircraft connecting cable bunch between the camera and camera controller, power may be supplied to the appropriate camera controllers through socket 48К (17) fixed directly on the camera tilting mount. The controller of camera А-ЭМ-1 is connected to the aircraft mains with the aid of socket 48К (24) installed on the main panel of the navigator-operator.

Installation of Electric System Units

Units of the electric system are arranged in the aircraft in the following places:

1. On the navigator's starboard console - camera hatch door control 3, BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) - AERIAL RECONNAISSANCE (РАЗВЕДКА) selector 4, tilting angle selector 9, button 7, relay 8, indicating lamps of the camera hatch doors open position and functioning of the camera controller for bombing control and aerial reconnaissance.

2. On the tilting mount - electric mechanism МУФ-2 (29 and 37), limit switches in the camera controller governing circuits engaged for bombing control and aerial reconnaissance (19, 20, 22, 30, 31, 32, 33, 34, 35, 23), contactors 10 and 18 and relays 21 and 36 controlling electric mechanism МУФ-2.

3. In the photographic equipment junction box installed in frame No.22 - contactors 27 and 28 controlling electric mechanism УР-7М and fuses НП-10.

4. At the camera hatch doors - electric mechanism УР-7М (26), limit switches 14 and 15 in control circuits of electric mechanism УР-7М and limit switches 12 and 13 interlocking the camera control circuit.

APPENDIX

MODIFICATIONS INCORPORATED
AFTER THE BOOK HAS BEEN PUBLISHED

Electrical Equipment

1. To avoid premature consumption of gasoline from the fifth group of the tanks, the system of engagement of the fifth group tanks has been modified. The pumps in question automatically come into operation for the standby duty only when the pumps of the fourth group of tanks are changed over from the standby to the normal duty.

2. For ensuring the installation of the set of electric fuel quantity gauge СЭТС-60М (instead of the СЭТС-60 set) some aircraft have additional portion of electric cables laid from the fuel quantity gauge amplifier to the indicators so that the СЭТС-60М set should be installed in the aircraft without incorporating modifications into the aircraft circuit.

3. The drag parachute extension system of some aircraft employs additional interlock for obviating spontaneous disconnecting of the drag parachute in its container before the RELEASE (ВЫПУСК) button has been pressed.

4. To improve the attachment of the tail unit de-icer system engagement mechanism (МКА-3А), the bolts of the mechanism attachment of steel ЗОХГСА are substituted for those of steel 10.

5. The power circuit of the heaters in the front and the rear pressurized cabins of some aircraft incorporate additional contactors, type КМ-200, with a view to obviate overheating of the cabin heating sections due to burning of the contacts of the relay К-50 located in the electric heater (unit 107).

6. To obviate accidental disengagement of the generators ГСР-18000, the generator panels of the operator are provided with special protectors for generator switches.

7. Spring-loaded lock is installed on the left engine control panel for locking the landing flap control selector in the neutral position.

8. To provide control over the voltage of the aircraft storage battery and the ground power source, two additional positions "АКК" and "РАН" are introduced for the generator panel voltmeter selector.

9. To obtain a reliable contact between the terminal of the minus wires and the aircraft structure and to obviate the overflow of the check paint, the terminals of the minus wires, cross section 5.15-mm and over, are secured in the following manner: a coating of anti-corrosion putty is applied to the surfaces of the terminals contacting the aircraft structure, the terminal is secured with the aid of a screw, and then the transient resistance is measured and the check paint is applied.

10. The fuel transfer pump electric motor МВ-650 is replaced with standard motor, type МВ-650А, having a resistor in the circuit for ensuring the starting with the afterburner ON. As a result, the distribution boxes of pumps 461 have no resistors ПО-10-5 for engaging the pumps with electric motor МВ-650 for augmented duty.

Besides, the electric motor МВ-650А has a compound excitation for ensuring the engagement of the pumps directly for augmented duty.

11. To promote the reliable functioning of the fuel pumps, the circuits of the pumps of the third group of the tanks employ fusible cut-outs МП-50 instead of cut-outs МП-75, and wires c.s. 8.8 mm instead of wires, c.s. 5.15 mm.

12. The feed circuit of the power supply sources is changed as the Manufacturer has substituted the modified relay ДЭР-600А for the relay ДЭР-600. Relays ДЭР-600А and ДЭР-600 are interchangeable.

13. For promoting the operational properties, the storage half-batteries, type 12CAM-55, 55 amp-hr capacity, is fitted instead of storage half-battery, type 12CAM-53, 53 amp-hr capacity.

Besides, half-batteries 12CAM-55 have longer guaranteed service life (1 year instead of 6 months) and may also be stored longer.

The negative wire attachment bolt of the new-type storage battery has larger diameter (10 mm instead of 8 mm).

14. The white light filter of the indicating lamp is replaced with a blue one with a view to improving the visibility of the tilting mount AKAZN when employed for the aerial reconnaissance duties in the daytime.

15. The dome light NCM-45 is installed in the upper portion of hatch over frame No.13 and not on the port side of frame No.20 for ensuring the illumination of the L.G. nose wheel brace lock.

16. For ensuring greater safety of the pilots' ejection, the hinged bracket of lamps APY-9CL and KLCPK on the overhead electric panel of the pilots is modified so that it can move only in sympathy with, and against, flight.

17. To obviate burning of the receptacle contacts of the ground power source when it is being engaged, with the ground supply switch ON and for obviating the possibility of the ground supply contactor engagement before the storage battery relay disconnects the aircraft mains, interlocking of the contact through the relay PM-2 is introduced.

18. The Manufacturer no longer produces the relays PMM-A, so the ground power receptacle is interlocked with the aid of the relay TKE-210 located in the storage battery distribution box.

19. The APY-9OM-50 equipment is installed in the aircraft instead of equipment APY-9CL-45 with a view to improve the illumination conditions provided for the pilots and for the navigator.

20. Parachute ejection gun feed line circuit breakers are connected to the double-supply busbar but not to a normal busbar.

21. For controlling over the functioning of the hydraulic pump, a white indicator lamp is connected to the hydraulic pump feed circuit. The lamp is mounted on the central instrument panel of the pilots.

22. For improving the reliability of functioning of the third group of fuel tanks, the pumps with motors MB-650 are removed and pumps with motors MB-650A are installed instead.

23. For ensuring the engine starting in the air with the master switch disconnected, the connection diagram of the circuit breakers A3C-20 and midair starting buttons are modified.

24. For obviating the damage that might be inflicted to the limit switch rods of the drag parachute release indication system, switches BK2-140B-1 are fitted instead of switches BK2-141B.

25. Ultraviolet lighting lamp is fitted next to the second frame, port side, for providing better illumination of the dials of unit Index "225".

26. For ensuring the functioning of the fire equipment actuated by the power supplied from the storage battery, with the shut-off and cross-feed valve circuit breaker line being de-energized, the fire warning system and the carbon dioxide cylinder control system are fed from the triple-supply busbar instead of the double-supply busbar.

27. For ensuring greater duration of the pulse sent out to the serial camera, wire BB5 running from the electric release is replaced with wire BM3 running from the sight S-IIP.

28. For obviating an untimely consumption of the fuel from the fifth group of tanks, the connection diagram of the pumps of the fifth group of tanks is modified. The pumps in question get automatically engaged into the operation for

standby duty only when the pumps of the fourth group are switched over from standby duty to normal duty.

29. In some aircraft modified fuel quantity gauge СИГС-60М has been installed instead of fuel quantity gauge СИГС-60К.

Radio Equipment

1. Noise filter P-12 is fitted between units P12 and P13 in the section of cable No.12 for suppressing the noises appearing during the operation of the radar bombsight РБП-4.

2. An open antenna (like a folded-dipole antenna) and the static electricity reflectors are additionally installed on the port side for ensuring a stable operation of the radio compass АРК-5 No.2.

3. Filter АР17-30 is fitted between units АР-18 and АР17-5 in the gap of cable No.9 for reducing the interference produced by the ПРС-I and affecting receiver УС-9.

4. For protecting the ПРС-I station from the pulse interference of the fighters equipped with jamming stations and the distance measuring equipment as well as from the interferences ceused by the equipment carried aboard the aircraft and operating at frequencies close to that of the ПРС-I, noise protection unit АР17-22 and box АР1723 with modified units АР17-86 and АР17-86 are installed. Unit АР17-22 is fitted with five interconnected filters, which are supersonic delay lines mounted in the assembled guides and located on the panel support and on the wall of the case ejection chute.

Stations ПРС-I are completely removed from the aircraft and replaced with stations ПРС-I having units No.22, 23 and АР17-8Б (having special designation code) intended for operation with the sight ПС-48 of earlier make. In some aircraft, unit АР17-22, box АР17-23 and modified units АР17-3Д and АР17-8З are installed.

Note: Station ПРС-I is intended for operation in conjunction with sight ПС-53.

5. Loop antenna is shifted to the upper portion of the airframe and installed between frames No.14 and 15 for obviating the interference caused by the metal parts of the nose wheel and affecting the functioning of the receiver of automatic radio compass АРК-5 No.2.

6. A special visor is installed over the unit АР17-12 located in the tail compartment for protecting the unit against moisture.

7. Non-adjustable brackets are taken off and special adjustable brackets are installed in the aircraft to ease the levelling of unit АР17-1.

8. Special quick-acting unit locking mechanisms are installed for ease in changing units P5 or P6 from the operating to the stowed position, and vice versa.

9. For ensuring the monitoring when receiver УС-9 is operating in the "АРЧ" position, quick-operating relay closing the receiver antenna to the aircraft structure when the telegraph key is being used is installed on some aircraft.

10. Because of the breakage of the textolite end-pieces of the folded-dipole antennas of the command set and to the folded-dipole antenna of the automatic radio compass АРК-5, the end-pieces are provided in some aircraft and the antenna ends are finished as hemispheres. In some aircraft, the end-pieces are cut off flush with the insulators.

11. For reliable operation, a circular breaker is fitted in the dynamotor instead of fusible cutouts.

12. For ensuring easy communication between the operating stations engaged in tuning of units АР-17 and other stations on the ground, intercom system receptacle is fitted in the tail compartment under the rack where unit АР17-12 is installed and special cables are provided for operations to be done in the compartment.

13. The code signal panel of the transponder is set slanted with a view to improve the observation.

14. For photographing the range scale of unit АР17-21, the unit in question in some aircraft is provided with camera gun, type ПАУ-457.

15. For reducing the effect of the radio set РСИУ-3М on the КРПΦ, the antennas of the radio set in some aircraft are arranged in such a way that the front antenna (as viewed backward) connects to receiver No.2 and the rear antenna, to transmitter and receiver No.1.

16. Filter ВЧΦ-2 is introduced into the circuit of the РВ-2 transmitting antenna for obviating the effect of radio altimeter РВ-2 on the distance measuring equipment СД-I.

17. For controlling over the functioning of the transponder, a telephone outlet is fitted on the additional panel of the intercom system СПУ-10 of the pilot.

18. In some aircraft the connections are changed over in the following way:

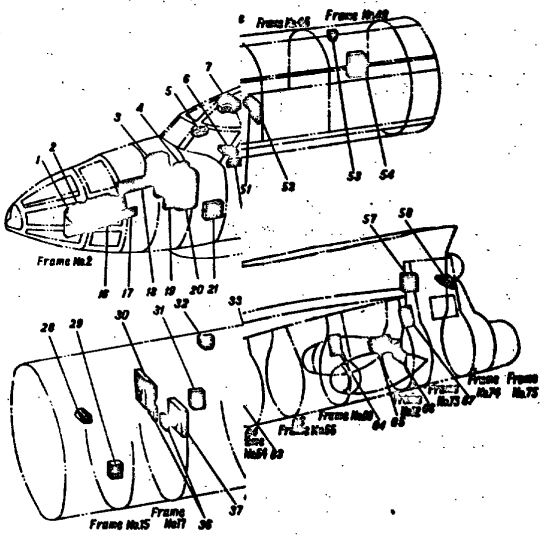
- АРК-5 No.1 - to the folded-dipole antenna;
- АРК-5 No.2 - to the blister antenna.

19. The static-electricity dischargers on the stabilizer of some aircraft are installed without the threaded adapters to prevent their breakage.

20. For improving the strength, the end-pieces of the stabilizer and fin static-electricity dischargers are modified.

21. Two static-electricity dischargers are installed on the wing tip cowl and the fin and three dischargers on the stabilizer for ensuring reliable discharge of static electricity of the aircraft structure.

The formula of the static-electricity discharger liquid is changed (80% of glycerine and 20% of ethyl alcohol instead of 80% of glycerine and 20% of water).



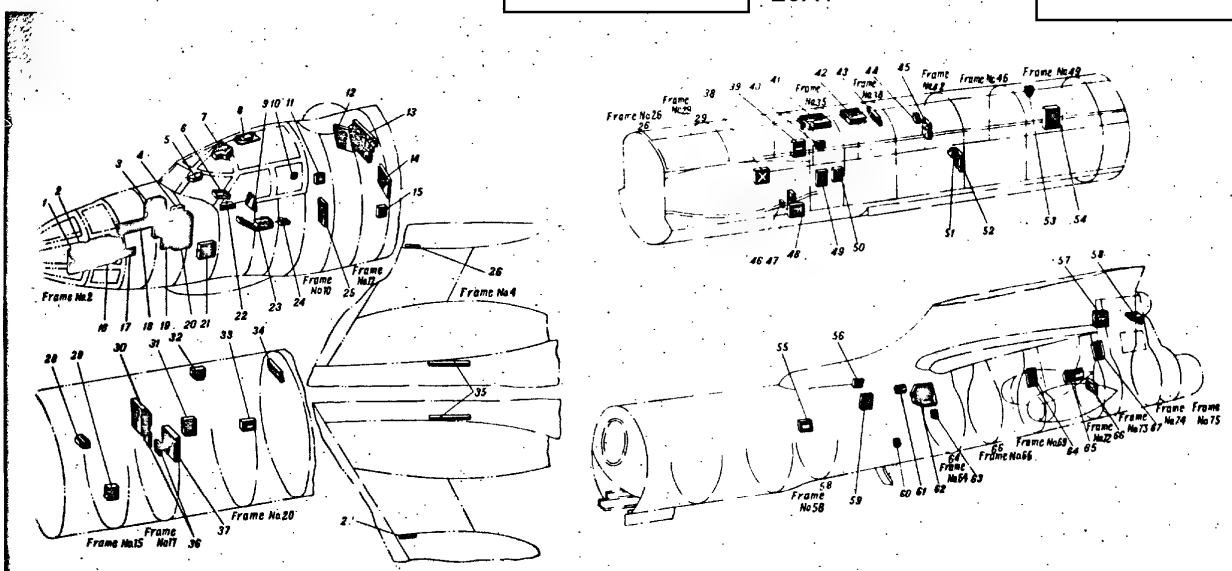


FIG. 1. SCHEMATIC LAYOUT DIAGRAM OF ELECTRIC EQUIPMENT CONTROL PANELS, BOARDS AND JUNCTION BOXES

1 – bomb bay door control board and navigator's camera control board; 2 – navigator's interphone control board; 3 – co-pilot's circuit-breaker control panel; 4 – glass panel heater junction box; 5 – co-pilot's trim tab control station; 6 – РУФО-45 ultra-violet illumination rheostat control board of co-pilot; 7 – fuel control supply board; 8 – overhead electric control board of pilots; 9 – co-pilot's fuelling control board; 10 – trim tab synchronization control station; 11 – operating ПО-4500 inverter junction box; 12 – right junction box; 13 – radar operator's generator control panel; 14 – left junction box; 15 – stand-by ПО-4500 inverter junction box; 16 – bomb release electric control board; 17 – bottom bomb release electric control board on navigator's left-hand console; 18 – navigator's upper electric control board; 19 – navigator's left circuit-breaker control panel; 20 – pilot's circuit-breaker control panel; 21 – front cabin dual power supply junction box; 22 – pilot's trim tab control station; 23 – pilot's electric control board; 24 – bomb release control station for bomb release, with the mains de-energized; 25 – front cabin sound signalling system junction box; 26 – right hand junction box of landing gear and fuel pump relay; 27 – left-hand junction box of landing gear and fuel pump relay; 28 – hydraulic pump junction box; 29 – external supply junction box; 30 – storage battery junction box; 31 – upper cannon mount fuse junction box; 32 – power junction box; 33 – camera equipment junction box; 34 – fuel quantity gauge junction box; 35 – left-hand and right-hand distribution panels; 36 – junction box of operating and standby inverters; 37 – dual power supply junction box; 38 – fuel pump junction box; 39 – emergency bomb release box; 40 – power junction box; 41 – landing flap junction box; 42 – bomb release system junction box; 43 – igniter junction box; 44 – emergency circuit junction box; 45 – dual power supply junction box; 46 – bomb bay interlocking limit switch mechanism; 47 – bomb bay limit switch junction box; 48 – fuel pump junction box; 49 – junction box of emergency bomb release, with the mains de-energized; 50 – additional pump junction box; 51 – emergency circuit junction box; 52 – dual power supply junction box; 53 – power junction box; 54 – fuel pump junction box, rear; 55 – range-finder power supply junction box; 56 – power junction box; 57 – rear cabin sound signalling system junction box; 58 – gunner's electric control board; 59 – blister mount fuse junction box; 60 – switch box and extension lamp receptacle; 61 – power junction box; 62 – tail unit de-icer junction box; 63 – auto-pilot heater circuit breaker box; 64 – tail cannon mount fuse junction box; 65 – rear cabin circuit-breaker control board; 66 – radio operator's electric control board; 67 – rear pressurized cabin junction box.

[redacted] 25X1 25X1 [redacted]

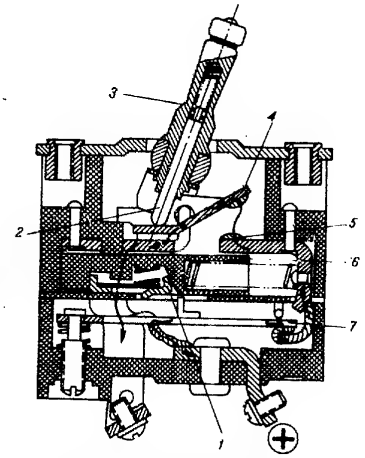


FIG. 2. AUTOMATIC CIRCUIT-BREAKER

1 – pawl; 2 – pin; 3 – lever; 4 – moving contact; 5 – fixed contact; 6 – block; 7 – bimetallic strip.

Note: The bold-line arrows in the diagram show the direction of current in the current-carrying elements of the circuit breaker.

25X1

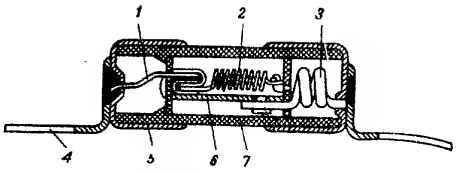


FIG. 3. DELAYED-ACTION FUSE LINK, TYPE ИП

1 – fuse wire; 2 – spring; 3 – heating element; 4 – tip; 5 – cap; 6 – current-carrying element; 7 – fibre tube.

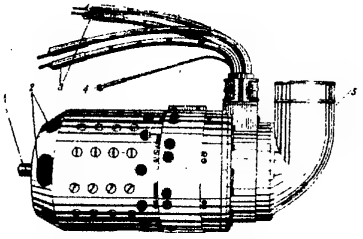


FIG. 4. GENERATOR, TYPE ГСР-18000

1 – spline shank of rotor torsion shaft; 2 – cooling vents; 3 – power wires; 4 – shunt winding wire; 5 – air intake sleeve.

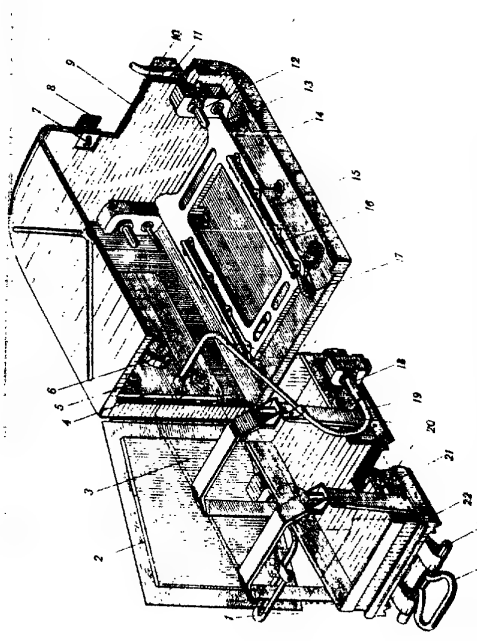


FIG. 5. CONTAINER OF 6-CAM-55 STORAGE BATTERY

1 – plus wire; 2 – container cover; 3 – hold-downs; 4 – heating element; 5 – heating strip contact bolt; 6 – thermal switch, type 7778; 7 – heating element lead-out bolt; 8 – guide; 9 – thermal insulation (АТМИ); 10 – guide; 11 – connect pin lead-out terminal; 12 – connect pin; 13 – guide pin; 14 – container base; 15 – container base; 16 – guide rails; 17 – lug; 18 – connect section; 19 – minus wire; 20 – hold-down straps of hold-downs; 21 – bolt; 22 – carriage; 23 – pin; 24 – lock pin.

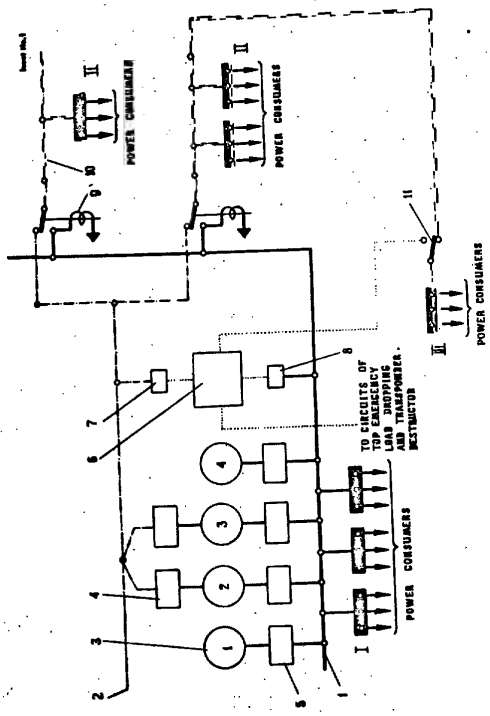
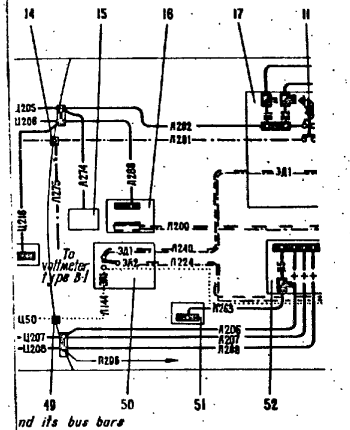


FIG. 6. D.C. POWER DISTRIBUTION DIAGRAM

1 – normal power supply circuit; 2 – emergency power supply circuit; 3 – generator, type ГСР-18000; 4 – differential under-current relay, type ДМР-600 (normal); 5 – differential undercurrent relay, type ДМР-600 (emergency); 6 – storage battery, type 12-САМ-55; 7 – connector, type К-300Д, for connecting storage battery to emergency power supply circuit; 8 – connector, type К-300Д, for connecting storage battery to normal power supply circuit; 9 – changeover contactor, type КП11; 10 – dual supply bus bars; 11 – changeover switch, type ПП-45; 12 – normal power supply bus bars; II – dual power supply bus bars; III – single power supply bus bar.



1 – tail station control box; 2
normal power supply circuit; 3
tion box; 8 – generator, type
11 – distribution panel, left; 1
14 – power lead from emergen
panel; 17 – dual supply junctio
rear; 20 – flare bomb emergenc
box of emergency power supply
25 – fuel pump junction box, ri
box; 29 – camera equipment ju
contactor, type К-400Д; 32 –
battery, type 12–САМ–55; 34 –
35 – hydraulic pump junction b
breaker control panel; 39 – nav
41 – ДСП-53 box; 42 – counte
junction box; 46 – autopilot hea
from emergency supply circuit;

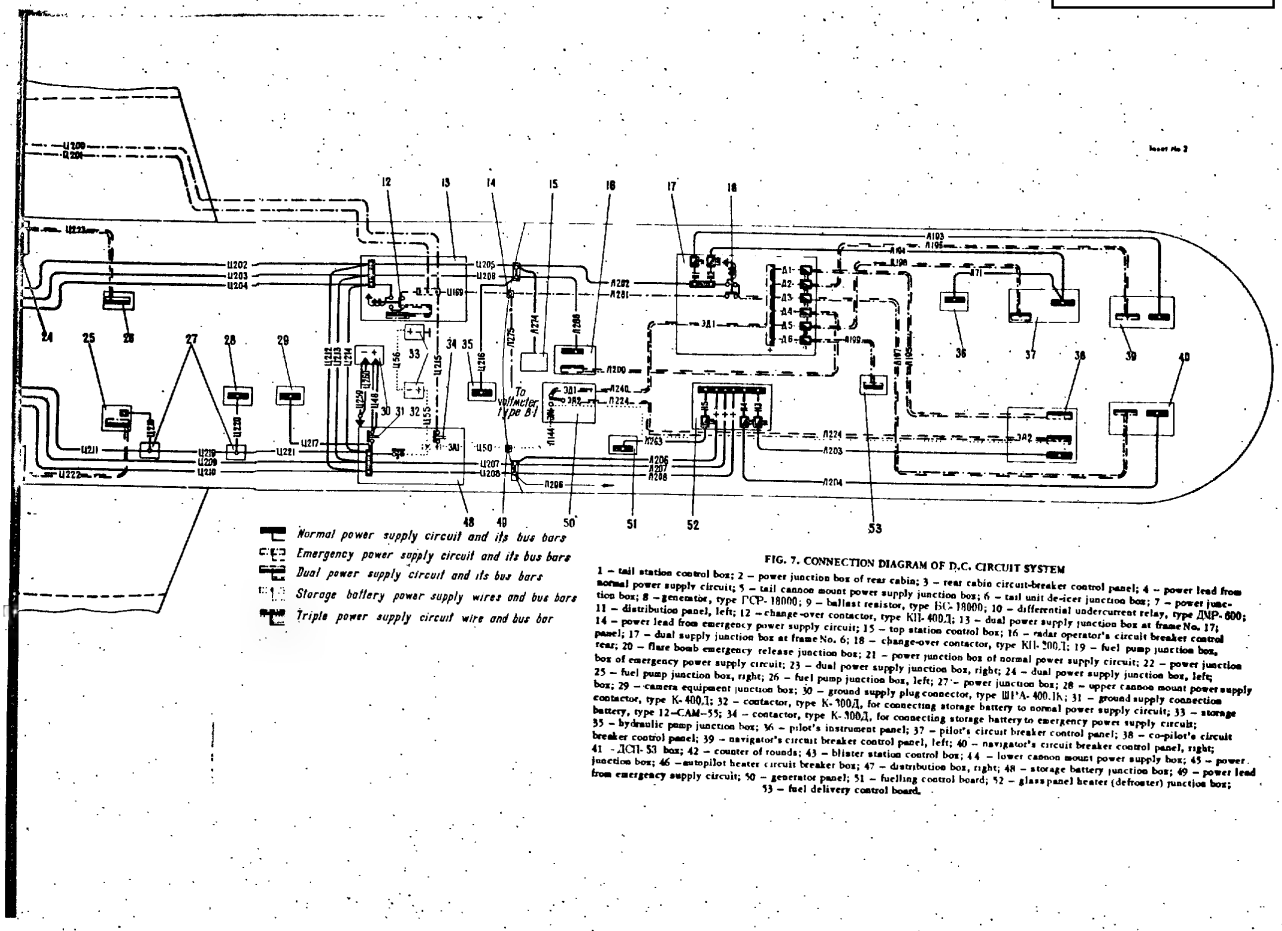
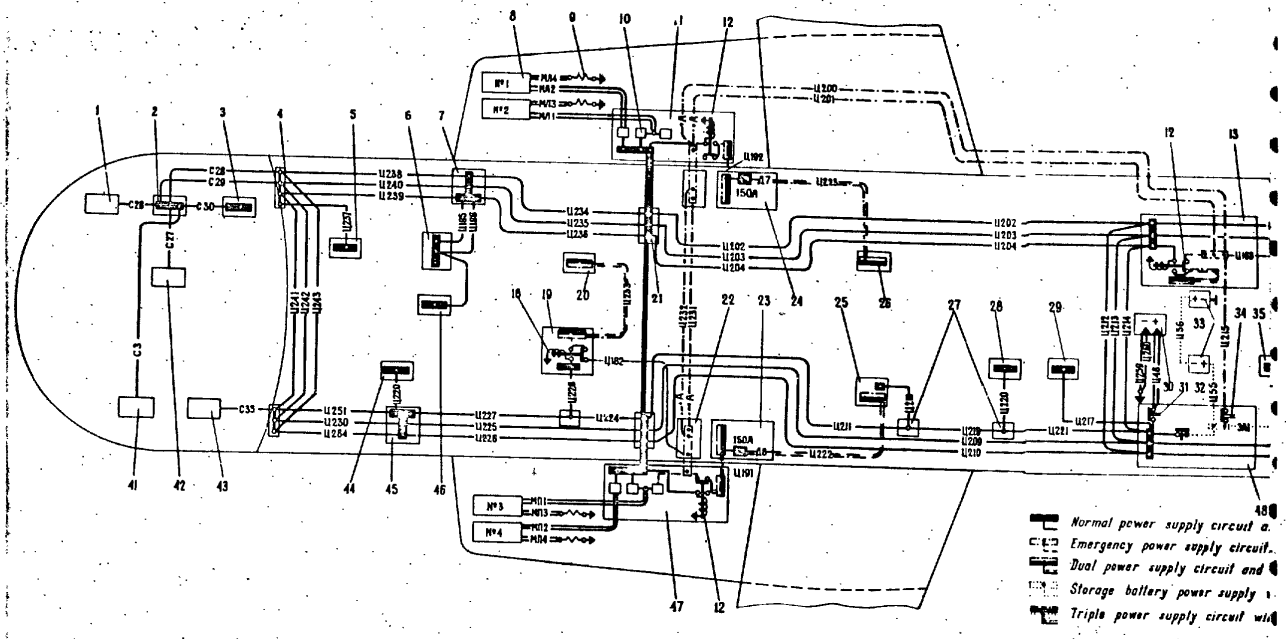


FIG. 7. CONNECTION DIAGRAM OF D.C. CIRCUIT SYSTEM

1 – tail station control box; 2 – power junction box of rear cabin; 3 – rear cabin circuit-breaker control panel; 4 – power lead from normal power supply circuit; 5 – tail cannon mount power supply junction box; 6 – tail unit de-icer junction box; 7 – power junction box; 8 – generator, type PCP- 18000; 9 – ballast resistor, type BC- 18000; 10 – differential undercurrent relay, type ДИР- 600; 11 – distribution panel, left; 12 – change-over contactor, type КП- 400Д; 13 – dual power supply junction box at frame No. 17; 14 – power lead from emergency power supply circuit; 15 – top station control box; 16 – radar operator's circuit breaker control panel; 17 – dual supply junction box at frame No. 6; 18 – change-over contactor, type КП- 200Д; 19 – fuel pump junction box, rear; 20 – flare bomb emergency release junction box; 21 – power junction box of normal power supply circuit; 22 – power junction box of emergency power supply circuit; 23 – dual power supply junction box, right; 24 – dual power supply junction box, left; 25 – fuel pump junction box, right; 26 – fuel pump junction box, left; 27 – power junction box; 28 – upper cannon mount power supply box; 29 – camera equipment junction box; 30 – ground supply plug connector, type Ш1'А- 400.1k; 31 – ground supply connection contactor, type К- 400.Д; 32 – contactor, type К- 100Д, for connecting storage battery to normal power supply circuit; 33 – storage battery, type 12–САМ–55; 34 – contactor, type К- 100Д, for connecting storage battery to emergency power supply circuit; 35 – hydraulic pump junction box; 36 – pilot's instrument panel; 37 – pilot's circuit breaker control panel; 38 – co-pilot's circuit breaker control panel; 39 – navigator's circuit breaker control panel, left; 40 – navigator's circuit breaker control panel, right; 41 – ДСП- 53 box; 42 – counter of rounds; 43 – blister station control box; 44 – lower cannon mount power supply box; 45 – power junction box; 46 – autopilot heater circuit breaker box; 47 – distribution box, right; 48 – storage battery junction box; 49 – power lead from emergency supply circuit; 50 – generator panel; 51 – fuelling control board; 52 – glass panel heater (defroster) junction box; 53 – fuel delivery control board.

25X1

25X1



25X1

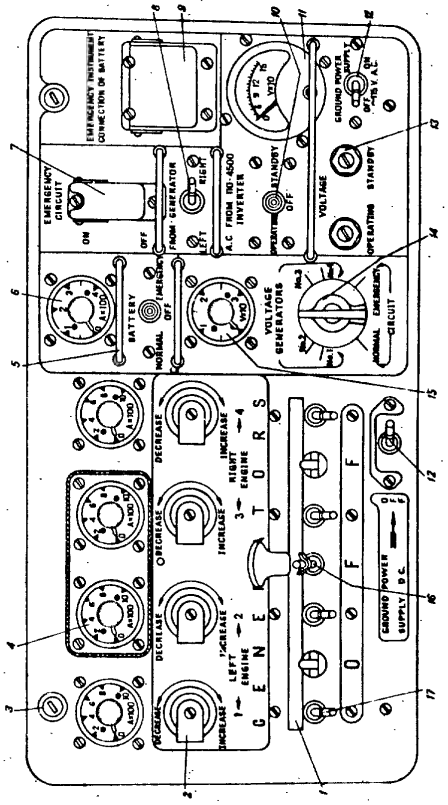
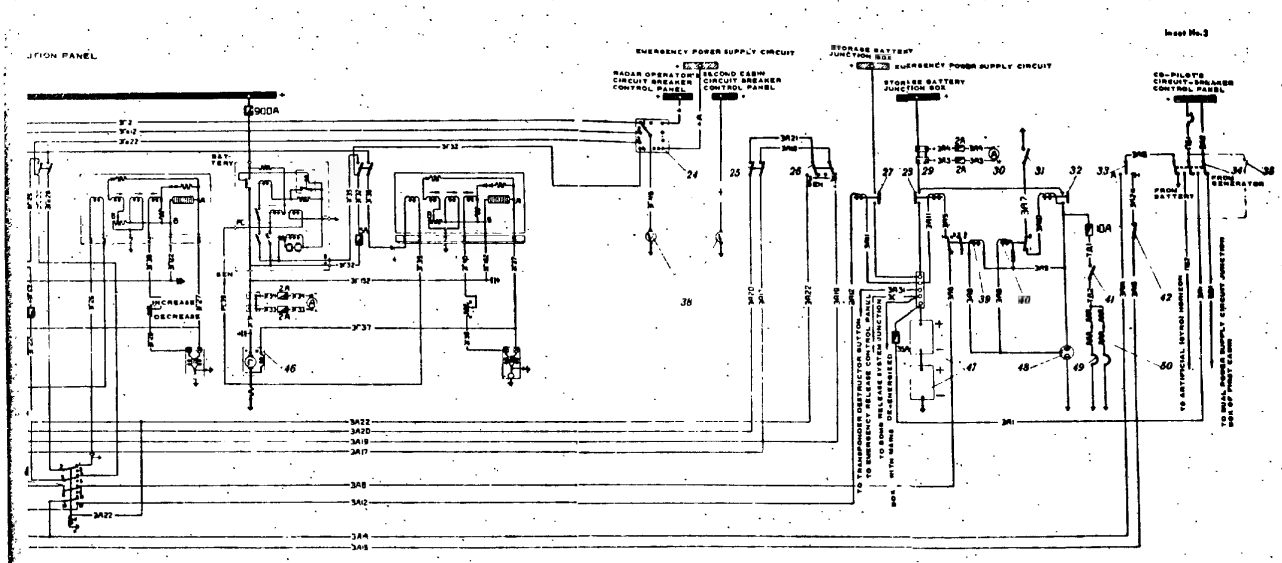


FIG. 6. GENERATOR CONTROL PANEL.

1 – master switch bar to simultaneously operate generator switches; 2 – extension resistor, type BC–20; 3 – panel attachment screw; 4 – ammeter, type A–3; 5 – safety clasp; 6 – ammeter, type A–1; 7 – protecting cover of switch, type 2B–45; 8 – change-over switch, type 2TD–45; 9 – cover of switches, type 2TD–45 and TD–45; 10 – change-over switch, type 3TD3–45; 11 – voltmeter, type B6–150; 12 – switch, type B–45; 13 – adjusting resistance, type PC–404; 14 – voltmeter change-over switch, type TI–46; 15 – voltmeter, type B–4; 16 – switch, type B–45, for disconnection of storage battery blocking from normal power supply circuit; 17 – generator switch, type 2B–45.



UIT DIAGRAM OF D.C. SUPPLY SOURCES

hunt of ammeter, ply circuit; ype PMP-2A; utomatic correc- tor; 19 – tempe- rgency power sup- ch, type 2B–45, power supply y to normal power 31; 32 – connector,

type K-400.1, for connecting ground power supply source to normal supply circuit; 33 – storage battery change-over switch, type ПМП-45; 34 – switches, types ПП-45 and 2ПП-45, of triple power supply bus bar; 35 – standby gyro horizon switch, type type B–45; 36 – ammeter, type A–3; 37 – extension resistance, type BC–20; 38 – voltmeter, type B–1; 39 – blocking relay, type РП-2; 40 – polarized relay, type РПП-А; 41 – switch, type B–45, of battery container heater; 42 – switch, type B–45, disconnecting storage battery from normal power supply circuit; 43 – stability transformer, type ТС–81; 44 – generator No. 2; 45 – generator No. 3; 46 – generator No. 4; 47 – storage battery, type 12–САМ–55; 48 – ground power supply plug connector; 49 – thermal switch, type 777В, of storage battery container heater; 50 – storage battery container heater element; 51 – connection diagram of generator, type ГСР-18000; 52 – main pole; 53 – commutating pole; 54 – blocking relay, type РП-6, for generator No. 2; 55 – blocking relay, type РП-6, for generator No. 3.

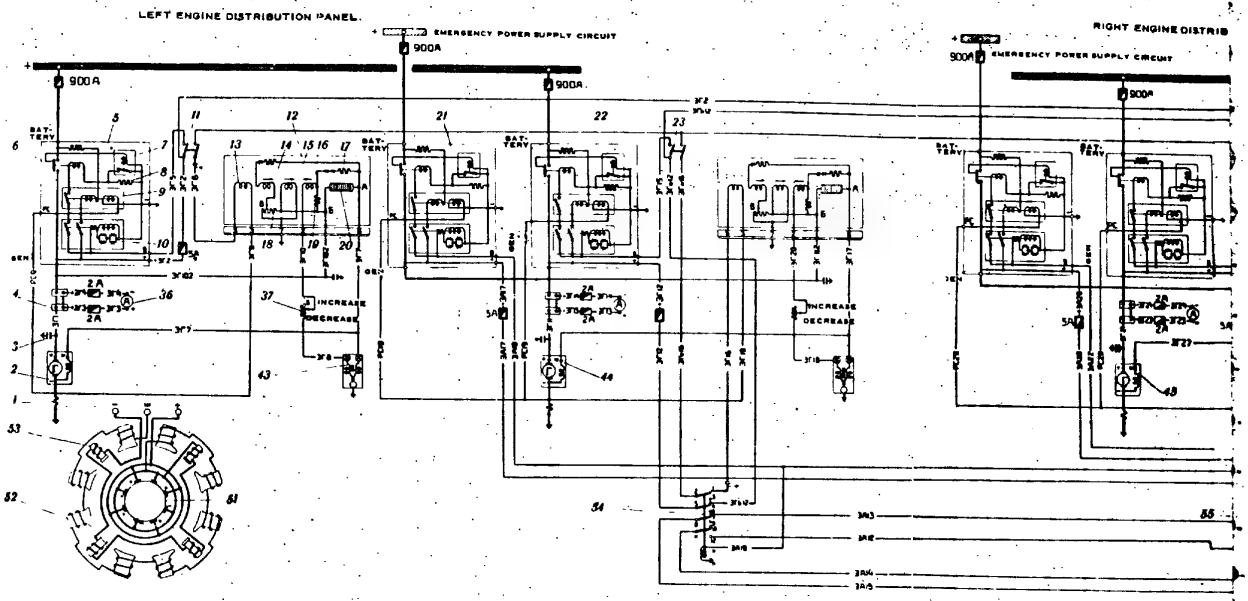


FIG. 9. CIRC

1 – ballast resistor, type БС-18000; 2 – generator, type ГСР-18000, No. 1; 3 – capacitor, type КВМ-31; 4 – a
type А-3; 5 – differential undercurrent relay, type ДМР-600, for connecting generator No. 1 to normal power su
6 – contactor; 7 – auxiliary relay, type РЛ-5Б; 8 – limiting resistor; 9 – command relay; 10 – polarized relay,
11 – switch, type 2В-45, of generator No. 1; 12 – carbon regulator, type РУТ-82; 13 – parallel winding; 14 –
tion winding; 15 – temperature compensation winding, 16 – working winding; 17 – stabilizing resistor; 18 – trim
rature compensation resistor; 20 – carbon pile; 21 – relay, type ДМР-600, for connecting generator No. 2 to emer
ply circuit; 22 – relay, type ДМР-600, for connecting generator No. 2 to normal power supply circuit; 23 – switc
of generator No. 2; 24 – voltmeter selector switch, type П-46; 25 – emergency circuit switch, type 2В-45; 26 –
change-over switch, type 2ПП-45, "from generator"; 27 – contactor, type К-300Д, for connecting storage batter
supply circuit; 29 – shunt of ammeter А-1; 30 – ammeter, type А-1; 31 – ground power supply switch, type В-4

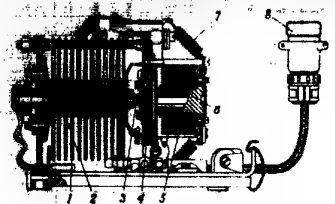


FIG. 10. CARBON REGULATOR, TYPE РУГ-82

1 – ribbed case; 2 – carbon pile; 3 – armature of electromagnet; 4 – plate springs; 5 – windings of electromagnet; 6 – core of electromagnet; 7 – shock springs; 8 – plug connector.

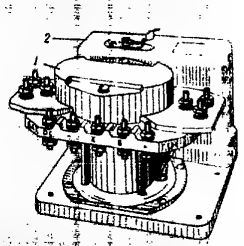


FIG. 11. DIFFERENTIAL RELAY, TYPE ДМР-600

1 – contactor; 2 – case of command relay, relay РМР-2А and relay РД-55, and resistors, type СП.

[redacted] 25X1

[redacted] 25X1

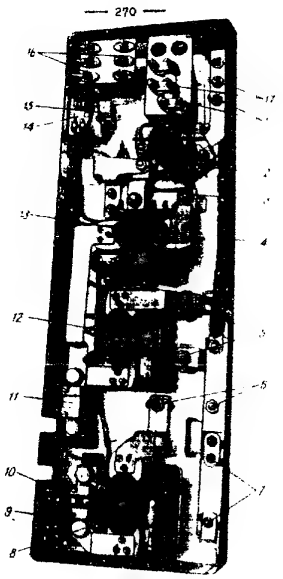


FIG. 12. DISTRIBUTION PANEL, LEFT

1 – location of fuse, type ИП-15, to protect fuel pump of tank 19; 2 – change-over contactor, type КП-400Д; 3 – location of fuse, type ТП-900, to protect generator No. 2 connected to emergency power supply circuit; 4 – terminal block; 5 – location of fuse, type ТП-900, to protect generator No. 2 connected to normal power supply circuit, 6 – location of fuse, type ТП-900, for generator No. 1 protection; 7 – location of delayed-action fuse, type ИП-300, for starter protection; 8 – relay, type ДМР-600, for generator No. 1; 9 – location of fuses, type (ТП-2), to protect ammeter of generator No. 1; 10 – shunt of А–3 ammeter of generator No. 1; 11 – shunt of А–3 ammeter of generator No. 2; 12 – ДМР-600 relay of generator No. 2 (normal); 13 – ДМР-600 relay of generator No. 2 (emergency); 14 – location of fuses, type СП-2, to protect ammeter of generator No. 2; 15 – blocking relay, type ПП-2, for blow-off band control; 16 – location of fuses, type ИП-3, to protect ДМР-600 relays of generators Nos 1 and 2; 17 – location of fuses, type ИП-30, to protect fuel pumps of tanks 18 and 19.

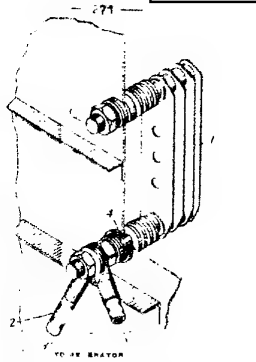


FIG. 13. INSTALLATION OF BALLAST RESISTOR, TYPE БС-18000

1 – ballast resistor, type БС-18000; 2 – generator minus wires, 3 – minus bolt, 4 – insulating washers.

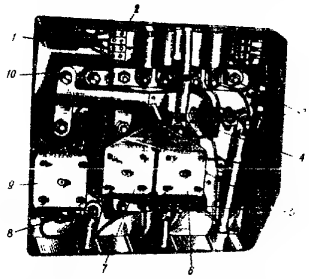


FIG. 14. STORAGE BATTERY JUNCTION BOX

1 – polarized relay, type РПП-А; 2 – terminal block; 3 – location of fuse, type ТП-400, to protect working converter, type ПО-4500; 4 – blocking relay, type РП-2; 5 – location of fuse, type ИП-35-2, to protect instrument power supply circuit under de-energized mains conditions; 6 – contactor, type К-300Д, for connecting storage battery to emergency power supply circuit; 7 – contactor, type К-300Д for connecting storage battery to normal power supply circuit; 8 – location of fuse, type СП-10, to protect storage battery heater circuit; 9 – contactor, type К-400Д for ground power supply source connection; 10 – shunt of ammeter, type А–1.

25X1

[redacted] 25X1 25X1 [redacted]

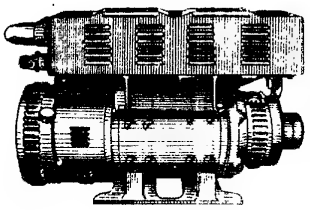


FIG. 15. INVERTER, TYPE ПО-4800

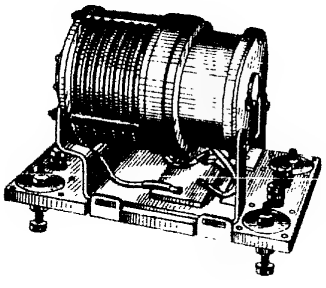


FIG. 16. CARBON REGULATOR, TYPE P-25B

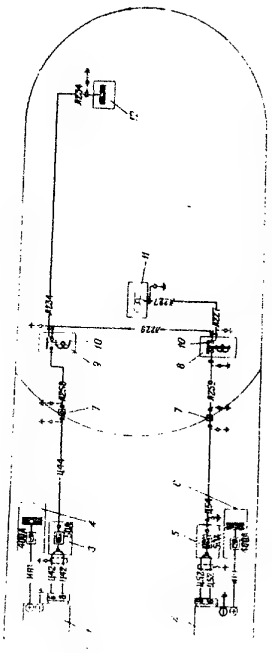


FIG. 17. A.C. POWER DISTRIBUTION DIAGRAM

1 – standby inverter, type ПО-4800; 2 – operating inverter, type ПО-4800; 3 – standby inverter junction box; 4 – dual power supply circuit junction box as shown No. 17; 5 – operating inverter junction box; 6 – storage battery junction box; 7 – A.C. power line box; 8 – relay box of operating ПО-4800 inverter on right-hand shelf of radar operator; 9 – relay box of standby ПО-4800 inverter on left-hand shelf of radar operator; 10 – connector, type К-302; 11 – A.C. bus panel of radar operator; 12 – A.C. bus panel of navigator.

25X1

25X1

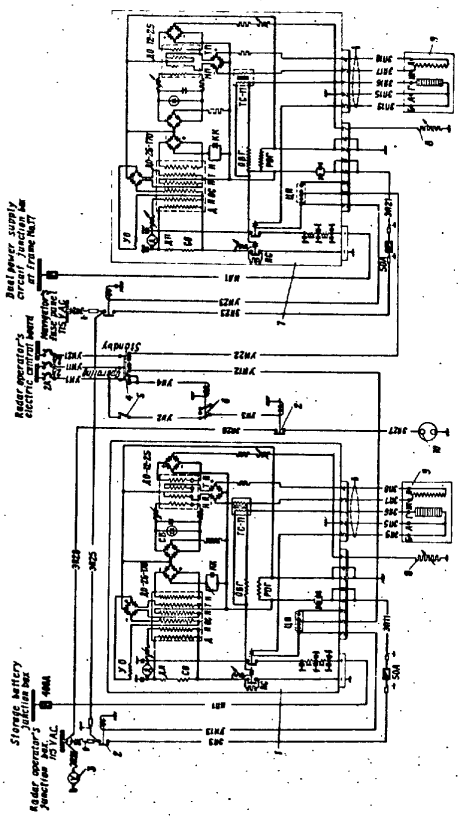


FIG. 18. CIRCUIT DIAGRAM OF A.C. SOURCES

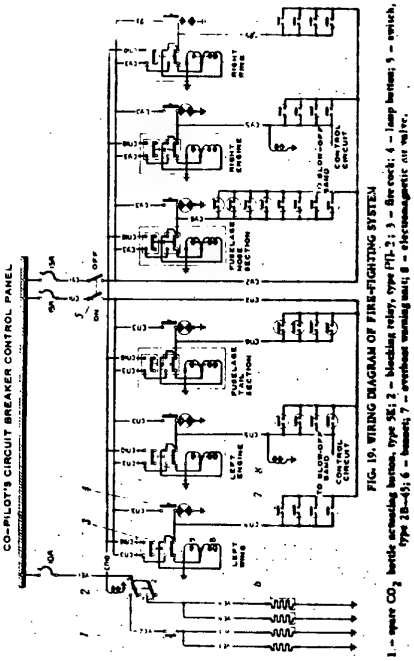


FIG. 19. WIRING DIAGRAM OF FIRE-FIGHTING SYSTEM

25X1

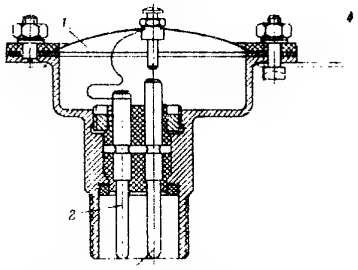


FIG. 20. OVERHEAT WARNING UNIT, TYPE TH

1 – bimetallic diaphragm; 2 – side contact; 3 – central contact.

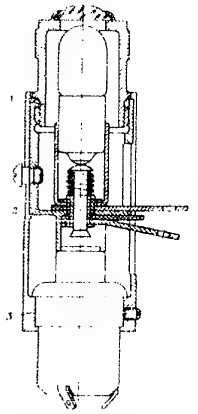


FIG. 21. LAMP BUTTON

1 – signalling lamp, type CM-51; 2 – signalling lamp holder; 3 – button, type 204K.

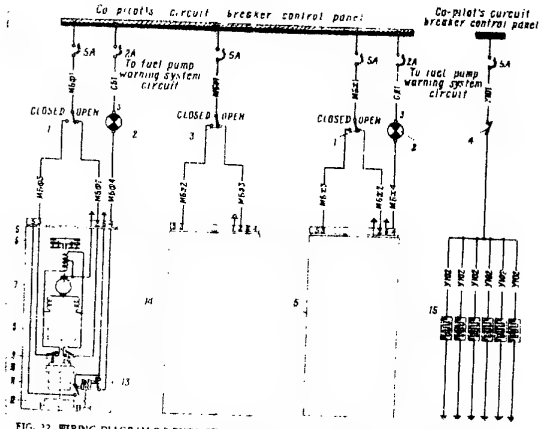


FIG. 22. WIRING DIAGRAM OF FUEL SHUT-OFF AND CROSS-FEED VALVE CONTROL SYSTEM AND OF INERT GAS CONTROL SYSTEM

1 – change-over switch, type ПП-45, for fuel shut-off valve control; 2 – signal (warning) light, type СЦЦ-51, indicating that fuel shut-off valve is open; 3 – change-over switch, type ПП-45, for cross-feed valve control; 4 – switch, type П-45, to actuate inert gas bottles; 5 – electric actuator, type МЭК-2, of fuel shut-off valve; 6 – electromagnetic brake clutch; 7 – electric motor; 8 – first three steps of planetary gear reduction unit; 9 – limit switches for electric motor extreme position control; 10 – fourth step of gear reduction unit; 11 – friction clutch; 12 – fifth step of gear reduction unit; 13 – limit switches for valve extreme position control; 14 – electric actuator, type МЭК-2, of cross-feed valve; 15 – discharge bonnet.

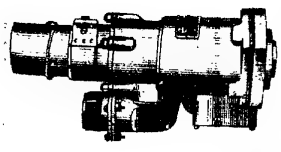


FIG. 23. ELECTRIC ACTUATOR, TYPE МЭК-2

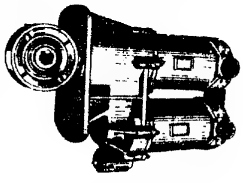


FIG. 24. ELECTRIC ACTUATOR, TYPE МЭ3-3М

25X1

S-E-C-R-E-T

[redacted] 25X1 [redacted]

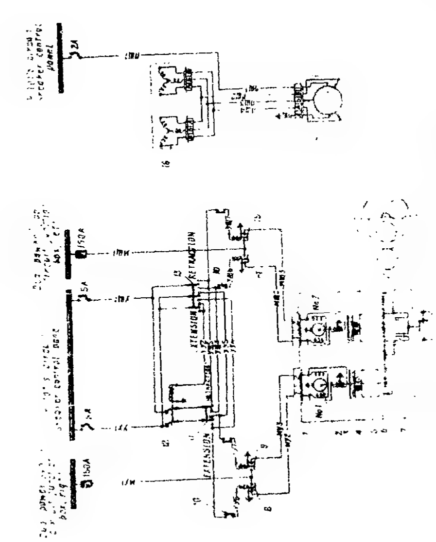


FIG. 25. CIRCUIT DIAGRAM OF LANDI[illegible] SYSTEM

1 – electric actuator, type МП[illegible]; 2 – actuator electric motor; 3 – electromagnetic clutch (engaging and braking); 4 – ball key; 5 – reduction unit; 6 – summation-type differential drive; 7 – friction clutch; 8 – contactor, type K–250, for flap [illegible] (electric motor No. 1); 9 – contactor, type K–250, for flap extension (electric motor No. 1); [illegible] for co-pilot's flap control; 12 – blocking relay; [illegible] switches, type MKB-11; 11 – change-over switch, type 2ПН-20, for co-pilot's flap control; [illegible] contactor, type K–250, for flap extension type [illegible]-2; 13 – change-over switch, type 2ППН-45, for pilot's flap control; [illegible] (electric motor No. 2); 15 – contactor, type K–250, for flap retraction (electric motor No. 2); 16 – flap position indicator, type УЗП-47; 17 – flap position transmitter, type УЗП-47.

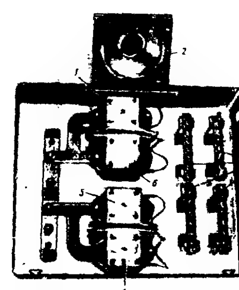


FIG. 26. LANDING FLAP SYSTEM JUNCTION BOX

1 – contactor, type K–250, for flap retraction (electric motor No. 1); 2 – dome, type ПС-45; 3 – terminal blocks; 4 – contactor, type K–250, for flap extension (electric motor No. 2); 5 – contactor, type K–250, for flap retraction (electric motor No. 2); 6 – contactor, type K–250, for flap extension (electric motor No. 1).

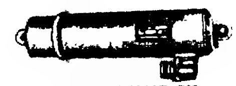


FIG. 27. ELECTRIC ACTUATOR, TYPE МП-100А-60

S-E-C-R-E-T

[redacted]

25X1

25X1 25X1

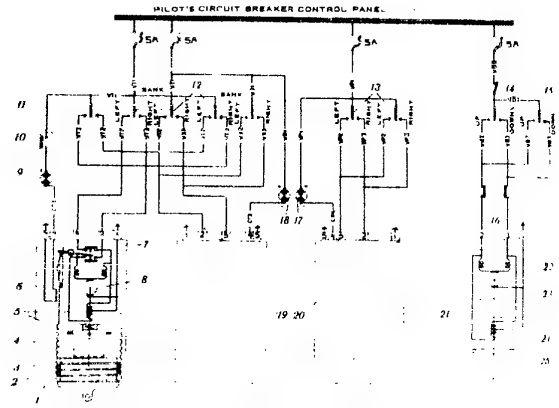


FIG. 28. CIRCUIT DIAGRAM OF TRIM TAB CONTROL SYSTEM

1 – electric actuator, type МП-100А-60, for left aileron trim tab control; 2 – rod nut of ball-type helical pair; 3 – screw of ball-type helical pair; 4 – reduction unit; 5 – electromagnetic brake clutch; 6 – actuating screw neutral position synchronization contact; 7 – limit switches; 8 – electric motor, 9 – signal (warning) light, type СЛЦ-51, indicating neutral position of left aileron trim tab; 10 – limit switch, type КВ-6–1, for warning light blocking. 11 – change-over switch, type ПН-45, for left aileron trim tab electric actuator control. 12 – push-type change-over switches, type ЗПН-20, for aileron trim tab electric actuator control; 13 – change-over switches, type ПН-45, for rudder trim tab electric actuator control; 14 – switch, type В–45, for emergency disengagement of rudder electric actuator control system; 15 – change-over switch, type ПН-45М, for elevator trim tab control; 16 – limit switches, type Вк2–142В, of electric actuator УТ-11; 17 – signal (warning) light, type СЛЦ-51, indicating neutral position of rudder trim tab; 18 – signal (warning) light, type СЛЦ-51, indicating neutral position of right aileron trim tab; 19 – electric actuator, type МП-100А-60 , of right aileron trim tab; 20 – electric actuator, type МП-100А-36, of rudder trim tab; 21 – electric actuator, type УТ-11, of elevator trim tab; 22 – first reduction unit (external gearing). 23 – electromagnetic engaging clutch; 25 – second reduction unit (planetary).

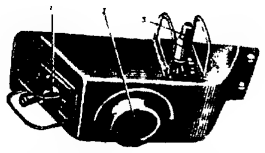


FIG. 29. PILOT'S TRIM TAB CONTROL STATION

1 – change-over switch, type ПН-45М, for rudder trim tab electric actuator control; 2 – button, type 5К, for drag chute release; 3 – change-over switch, type ЗПН-20, for aileron trim tab electric actuator control.

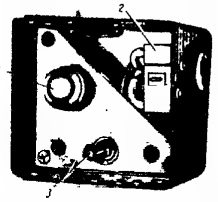


FIG. 30. AILERON TRIM TAB SYNCHRONIZATION STATION

1 – signal light, type СЛЦ-51, indicating neutral position of left aileron trim tab; 2 – limit switch, type КВ–6–1; 3 – change-over switch, type ПН-45М, for left aileron trim tab electric actuator control.

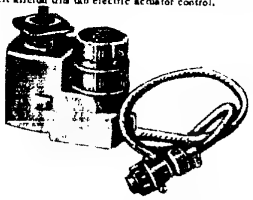


FIG. 31. GENERAL VIEW OF ELECTRIC ACTUATOR, TYPE УТ-11

25X1

25X1 [redacted] 25X1 [redacted]

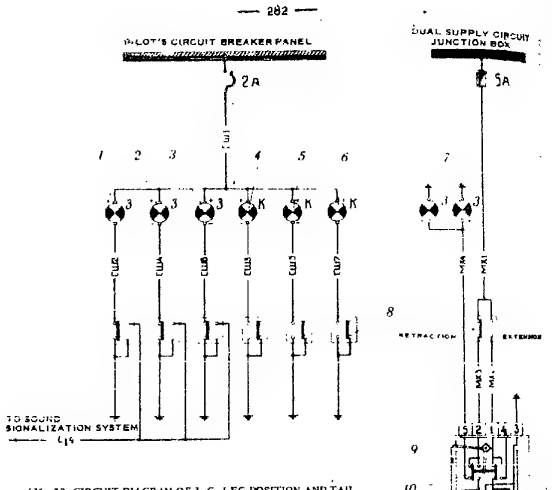


FIG. 32. CIRCUIT DIAGRAM OF L.G. LEG POSITION AND TAIL SKID CONTROL SYSTEMS

1 – signal light, type СШ-51, green, indicating extension of L.G. left leg; 2 – signal light, type СШ-51, green, indicating extension of nosewheel leg; 3 – signal light, type СШ-51, green, indicating extension of L.G. right leg; 4 – signal light, type СШ-51, red, indicating retraction of L.G. left leg; 5 – signal light, type СШ-51, red, indicating retraction of nosewheel leg; 6 – signal light, type СШ-51, red, indicating retraction of L.G. right leg; 7 – signal light, type СШ-51, green, indicating retraction of tail skid; 8 – limit switches, type ВК—44; 9 – electric actuator, type МП-250, for tail skid control; 10 – limit switches, 11 – electric motor; 12 – electromagnetic brake clutch; 13 – three-step planetary gear reduction unit; 14 – screw of ball-type helical pair; 15 – rod nut of ball-type helical pair.

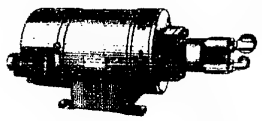


FIG. 33. GENERAL VIEW OF HYDRAULIC PUMP, TYPE 11Ш-29

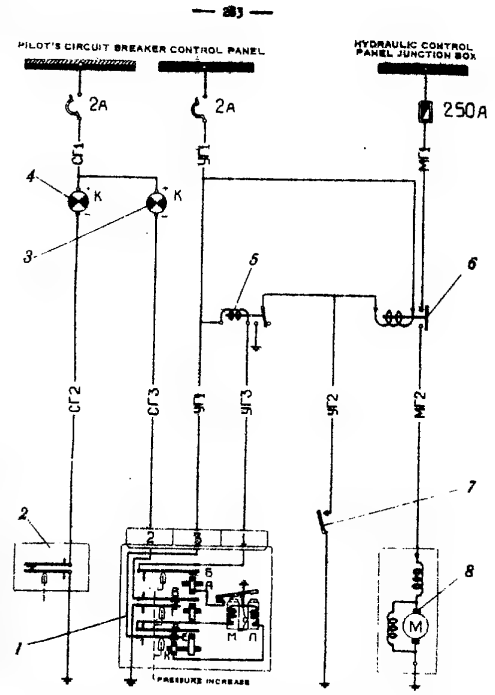


FIG. 34. CIRCUIT DIAGRAM OF HYDRAULIC PUMP CONTROL SYSTEM

1 – pressure selector, type ПДМЭ-150; А and Б – contacts closing at pressure of 50 kg/cm²; В and Г – contacts opening at pressure of 100 kg/cm²; Д and Е – contacts opening at pressure of 120 kg/cm²; Ж and К – contacts closing at pressure of 150 kg/cm²; Л and М – coils of blocking relay; 2 – pressure drop warning unit, type СПМ-120; 3 – signal light, type СШ-51, red, indicating pressure drop in normal hydraulic system; 4 – signal light, type СШ-51, red, indicating pressure drop in emergency hydraulic system; 5 – blocking relay, type РП-3, for hydraulic pump control; 6 – contactor, type К-400Д; 7 – switch, type ВКГ-45Б, for manual engagement of hydraulic pump; 8 – hydraulic pump, type 11Ш-29.

25X1

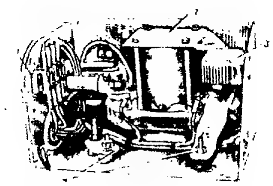


FIG. 35. HYDRAULIC CONTROL PANEL JUNCTION BOX

1 – terminal box; 2 – contactor, type К-400,Д, for hydraulic pump engagement; 3 – blocking relay, type [illegible] for hydraulic pump control; 4 – location of delayed action fuse, type ПП-200.

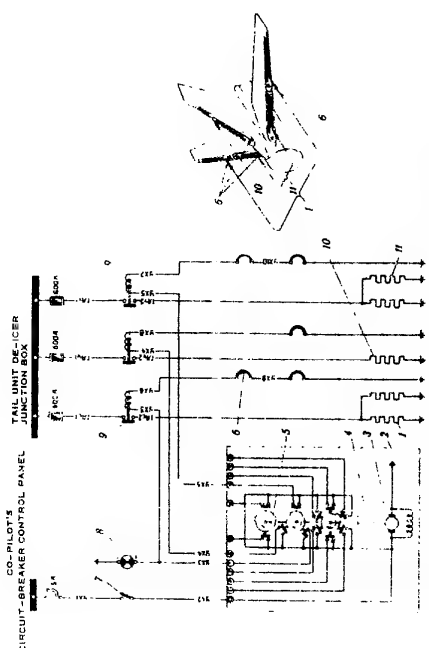


FIG. 36. CIRCUIT DIAGRAM OF TAIL UNIT DE-ICER SYSTEM

1 – external sections (boots) of stabilizer de-icer system; 2 – electric actuator, type МКА-3А; 3 – electric motor; 4 – four-step planetary gear reduction unit; 5 – contact assembly; 6 – thermal switch, type 777-Б; 7 – switch, type В-45; 8 – signal light, type СПП-51, with white light filter; 9 – contactor, type К-[illegible]; 10 – fin de-icer section (boot), 11 – internal de-icer sections of stabilizer.

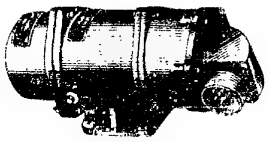


FIG. 37. GENERAL VIEW OF ELECTRIC ACTUATOR ЭПМ-МКА-5А

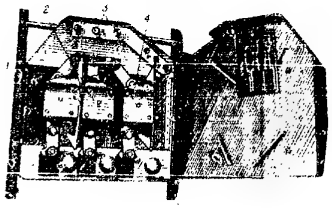


FIG. 38. TAIL UNIT DE-ICER SYSTEM JUNCTION BOX

1 – contactor, type K-600Д, of external de-icer section of stabilizer; 2 – contactor, type K-600Д, of fin de-icer section; 3 – bolts for attaching fuses, type ПП-600; 4 – contactor, type K-660 for internal de-icer section of stabilizer.

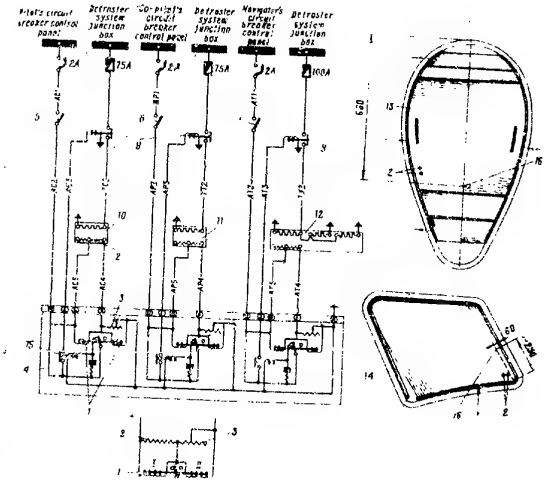


FIG. 39. CIRCUIT DIAGRAM OF DEFROSTER (GLASS PANEL HEATING) SYSTEM

1 – polarized differential relay, type РП-4; 2 – thermister; 3 – control rheostat; 4 – automatic defroster control unit, type АОС-81М; 5 – switch, type В-45, of pilot's defroster; 6 – switch, type В-45, of co-pilot's defroster; 7 – switch, type В-45, of navigator's defroster; 8 – contactor, type К-50Д; 9 – contactor, type К-100Д; 10 – pilot's glass panel; 11 – co-pilot's glass panel; 12 – navigator's glass panel; 13 – layout of heater elements in navigator's glass panel; 14 – layout of heater element in pilot's glass panel; 15 – relay, type РПЭ-45; 16 – glass temperature measurement point.

[redacted] 25X1 [redacted] 25X1

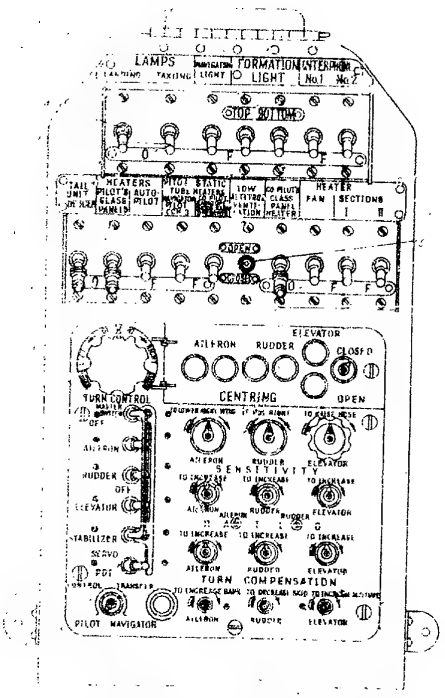


Fig. 42. UPPER (OVERHEAD) ELECTRIC CONTROL BOARD OF PILOTS' COMPARTMENT

1 – autopilot control panel; 2 – extension; 3 – switch, type B-45; 4 – change-over switch, type 2BB-45; 5 – change-over switch, type BB-45A.

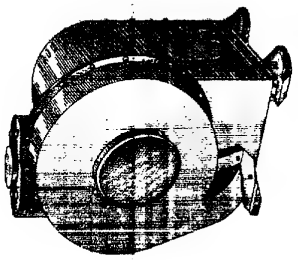


FIG. 43. GENERAL VIEW OF ELECTRIC HEATER, INDEX 107

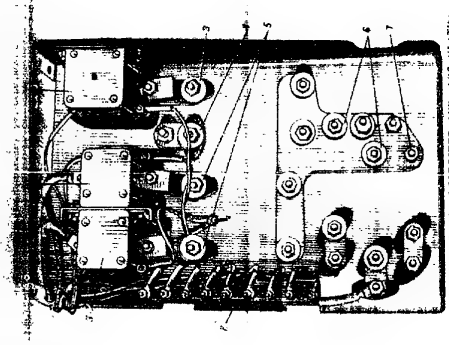


FIG. 41. GLASS PANEL DEFROSTER AND ANTI-ICING SYSTEM JUNCTION BUS

1 – connector, type K-501, for copilot's glass panel heater; 2 – connector, type K-1001, for navigator's glass panel heater; 3 – location of fuse, type HB-150, for navigator's glass panel heater; 4 – location of fuse, type HB-150, for front pressurized cable heaters; 5 – location of fuses, type HB-75, for heaters of pilot's and copilot's glass panels; 6 – location of glass panels' rear pressurized cable heaters; 7 – connector, type K-501, for navigator's glass panel heater; 8 – terminal block; 9 – connector, type K-501, for pilot's glass panel heater.

25X1

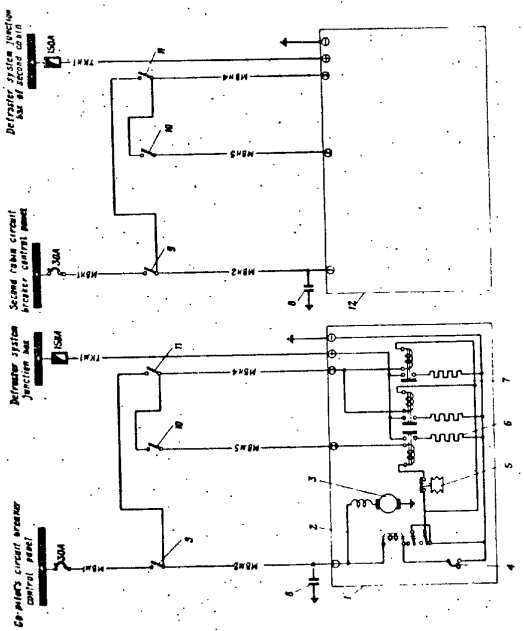


FIG. 43. CIRCUIT DIAGRAM OF CABIN HEATERS

1 – heater (Index 107) of front pressurized cabin; 2 – blocking relay, type РТЛ-2; 3 – ventilator electric motor; 4 – thermal switch; 5 – altitude change-over switch; 6 – heating elements; 7 – connector, type КБШ-31; 8 – fan switch; 9 – fan switch; 10 – control section switch; 11 – fuse section switch; 12 – heater (Index 107) of rear pressurized cabin.

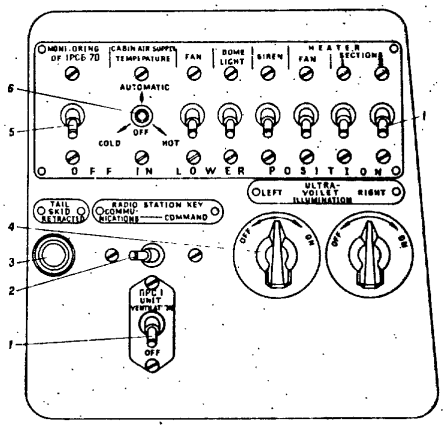


FIG. 44. RADIO OPERATOR'S ELECTRIC CONTROL BOARD

1 – switch, type В-45; 2 – change-over switch, type ПП-45; 3 – signal light, type СЛЦ-51, with green filter; 4 – rheostat for ultra-violet illumination control, type РЗ ФО-45; 5 – change-over switch, type 2ПП-45; 6 – change-over switch, type П2НПП-45.

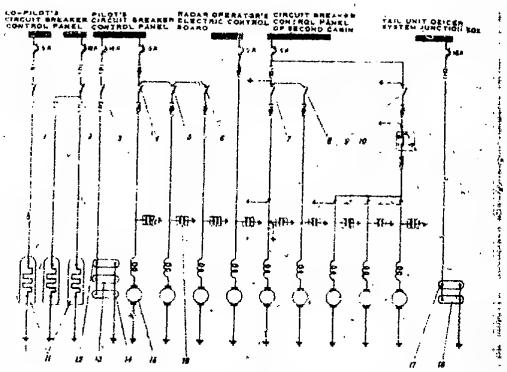


FIG. 45. CIRCUIT DIAGRAM OF INSTRUMENT FANNING AND HEATING SYSTEMS

1 – switch, type B–45, of heaters of ПИ-156 pitot tube of pilot, navigator and ССН–3 velocity head warning unit; 2 – switch, type B–45, of heaters of pitot tube of co-pilot, radio operator, radar operator, and of heaters of instruments, types ИИ-50Б (air position indicator) and ОПБ-11р (sight); 3 – switch, type B–45, of АП-5-2М autopilot heaters; 4 – switch, type B–45, of navigator's fan; 5 – switch, type B–45, of pilot's fan; 6 – switch, type B–45, of co-pilot's fan; 7 – switch, type B–45, of radio-gunner's fan; 8 – switch, type B–45, of gunner's fan; 9 – switch, type B–45, of fans airing the units of radar station ПРС-1; 10 – limit switch, type ВК–44, of fans airing the units of radar station ПРС-1; 11 – electric heating element of pitot tube ПТ-156; 12 – socket of autopilot directional stabilizer heater; 13 – socket of autopilot vertical gyro heater; 14 – socket of autopilot aileron servo unit heater; 15 – fan, type ДВ-3; 16 – capacitor, type КБМ-31; 17 – socket of autopilot elevator servo unit heater; 18 – socket of autopilot rudder servo unit heater.

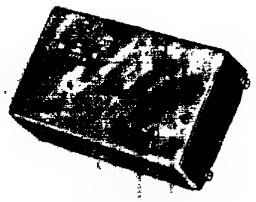


FIG. 46. GENERAL VIEW OF THERMOSTAT, TYPE РТВК 45

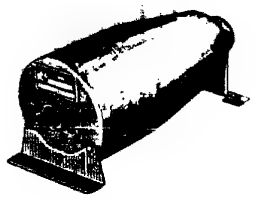


FIG. 47. GENERAL VIEW OF ELECTRIC ACTUATOR, TYPE МРТ–1

25X1 25X1

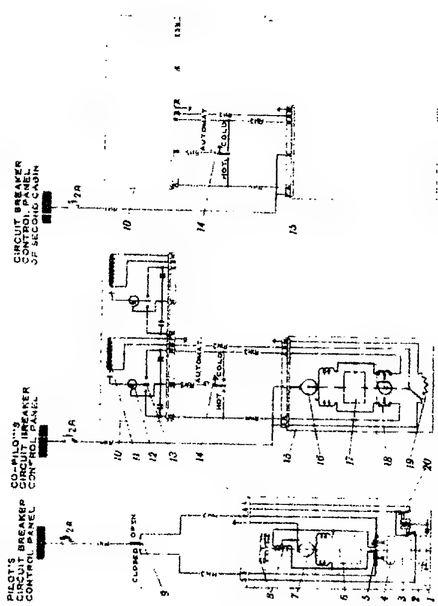


FIG. 48. CIRCUIT DIAGRAM OF ALTITUDE EQUIPMENT

1 – electric actuator, type [illegible], for low altitude ventilation; 2 – fifth step of planetary gear reduction unit; 3 – friction clutch; 4 – fourth step of planetary gear reduction unit; 5 – limit switches; 6 – first three steps of planetary gear reduction unit; 7 – electric motor; 8 – electromagnetic clutch (engaging and braking); 9 – change-over switch, type [illegible], for low altitude ventilation system; 10 – cabin thermostat (thermoregulator), type [illegible]; 11 – feedback (balance) [illegible]; 12 – [illegible]; 13 – electric actuator, type [illegible]; 14 – [illegible]; 15 – [illegible]; 16 – electric [illegible]; 17 – [illegible]; 18 – limit switches; 19 – feedback (balance) potentiometer; 20 – warning unit limit switch.

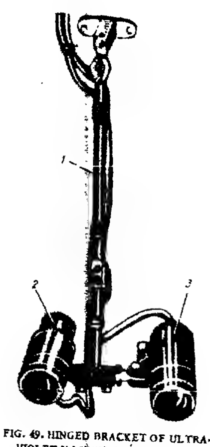


FIG. 49. HINGED BRACKET OF ULTRA-VIOLET ILLUMINATION LAMPS

1 – hinged bracket; 2 – ultra-violet illumination lamp, type АРУФОШ-45; 3 – cabin lamp, type КЛСРК-45.

25X1

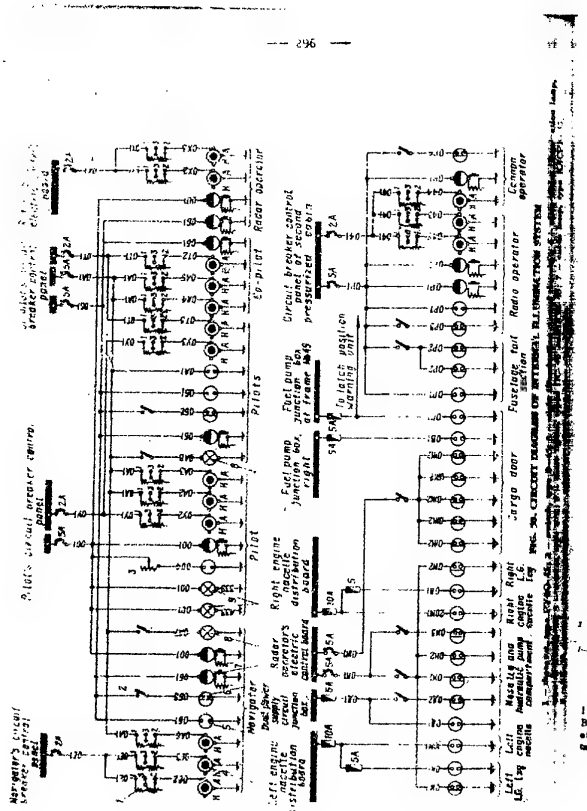


FIG. 51. GENERAL VIEW OF LANDING LAMP, TYPE ЛФСІЗ-45

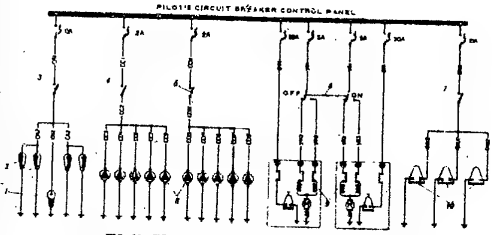
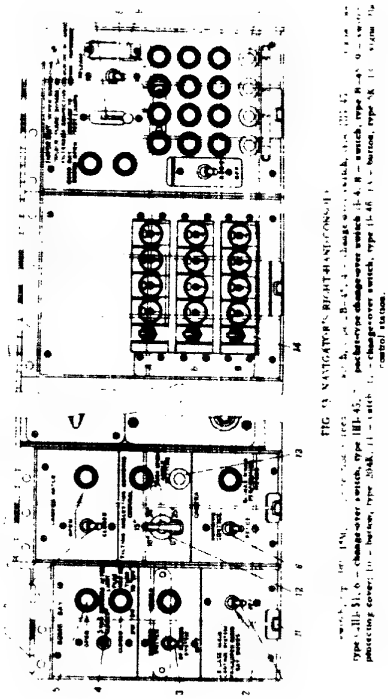


FIG. 52. CIRCUIT DIAGRAM OF EXTERIOR LIGHTING SYSTEM

1 – tail navigation light, type ХС–39; 2 – wing navigation light, type БАНО-45; 3 – switch, type В–45, of navigation lights; 4 – switch, type В–45, of top formation lights; 5 – switch, type В–45 of bottom formation lights; 6 – switch, type ПІІІ-45, of landing lamps; 7 – switch, type В–45, of taxiing lamps; 8 – formation light, type ПСОФ-45; 9 – landing lamp, type ЛФСІЗ-45; 10 – taxiing lamp, type ФР-100.

25X1

25X1



25X1

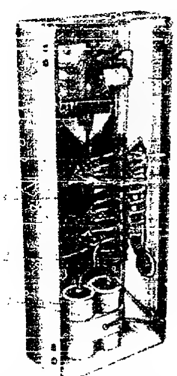


FIG. 55. SOUND SIGNALLING SYSTEM RELAY BOX, FRONT PRESSURIZED CABIN

1 — capacitor, type KR-1A-30 $\frac{40}{ohm}$ V; 2 — alarm relay, type PII-2; 3 — relay, type PII-2, to break intermittent signalling; 4 — terminal block; 5 — buzzer relay, type PII-12, for intermittent signalling of cabin pressure drop.

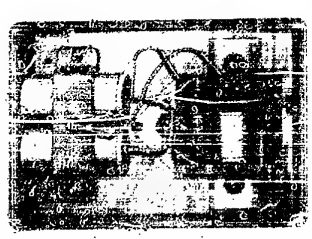


FIG. 56. SOUND SIGNALLING SYSTEM RELAY BOX, REAR PRESSURIZED CABIN

1 — capacitor, type KS-1A-30 $\frac{20}{ohm}$ V; 2 — buzzer relay, type PII-12, for intermittent signalling of cabin pressure drop.

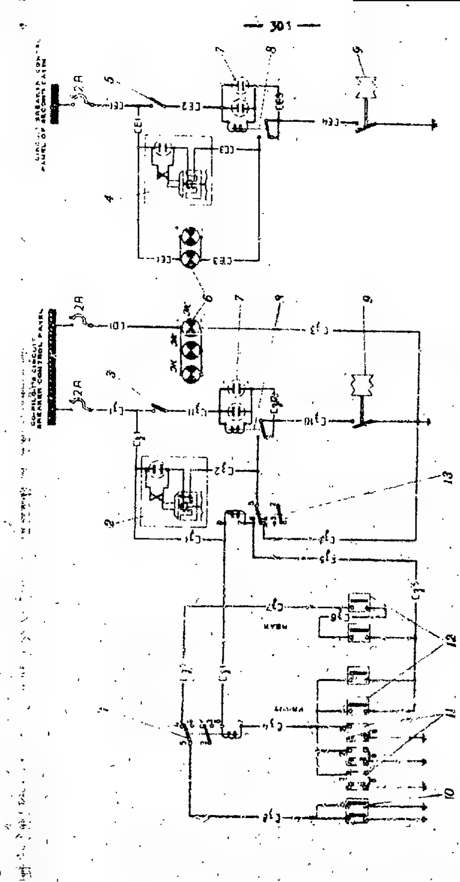


FIG. 57. CIRCUIT DIAGRAM OF SOUND AND LIGHT SIGNALLING SYSTEMS

1 — alarm relay, type PII-2; 2 — siren, type C-1, in front pressurized cabin; 3 — switch, type B-45, of pressure drop warning system in front pressurized cabin; 4 — siren, type C-1, in rear pressurized cabin; 5 — switch, type B-45, of pressure drop warning system in rear pressurized cabin; 6 — signal lights, type CIIII-51 (yellow) indicating pressure drop in pressurized cabins; 7 — capacitors, type KS-1A-30 $\frac{50}{ohm}$ V; 8 — buzzer relay, type PII-12, for intermittent signalling of cabin pressure drop; 9 — cabin altitude warning unit, type BC-46; 10 — limit switch mechanism, type MKB-2; 11 — limit switches, type BK-44, of L.G. extended position (main legs); 12 — limit switches, type BK2-[illegible]; 13 — relay, type PII-2, to break intermittent signalling.

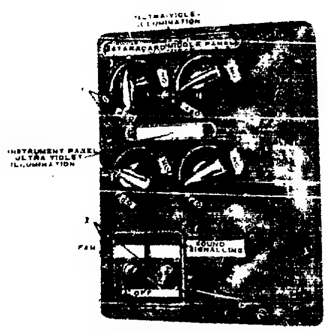


FIG. 58. CO-PILOT'S RHEOSTAT CONTROL BOARD

1 – ultra-violet illumination rheostats, type РУФО-45; 2 – switches, type В-45.

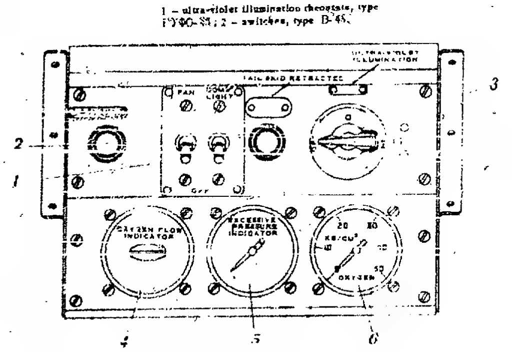


FIG. 59. GUNNER'S ELECTRIC CONTROL BOARD

1 – switch, type В–45. 2 – signal light, type СЛШ-51; 3 – ultra-violet illumination control rheostat, type РУФО-45; 4 – oxygen flow indicator; 5 – excessive pressure indicator; 6 – oxygen pressure gauge.

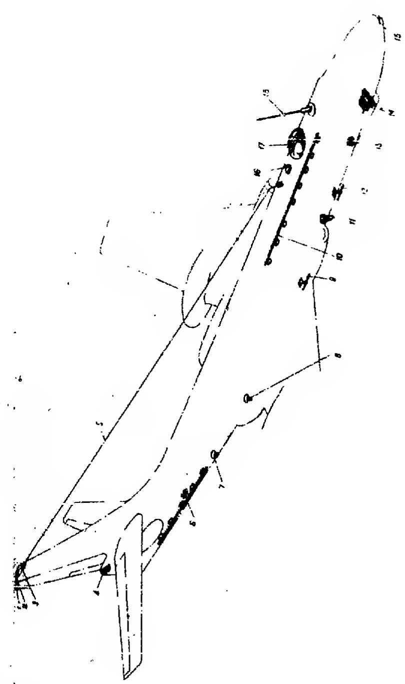


FIG. 60. AIRCRAFT ANTENNAS LAYOUT DIAGRAM

1 – transmit-receive antenna of radio set РСИУ-3М; 2 – receiving antenna of receiver No. 2 of the radio set РСИУ-3М; 3 – antenna of receiver КРП-Ф; 4 – antenna of gun radar sight ПРС-1; 5 – wire antenna of radio communication station 1-РСБ-70; 6 – inboard antenna МРП-48П; 7 – transmitting antenna СД-1; 8 – receiving antenna СД-1, 9 – altimeter transmitting antenna; 10 – folded-dipole antenna of station 1-РСБ-70М; 11 – transmit-receive antenna of IFF transponder; 12 – altimetre receiving antenna; 13 – antenna No. 2 of automatic radio compass АРК-5; 14 – antenna of radar bomb sight РПБ-4; 15 – antenna of receiver УРП-2; 16 – loop antenna No. 1 of automatic radio compass АРК-5. 17 – antenna No. 2 of automatic radio compass АРК-5; 18 – rod antenna No. 1 of automatic radio compass АРК-5.

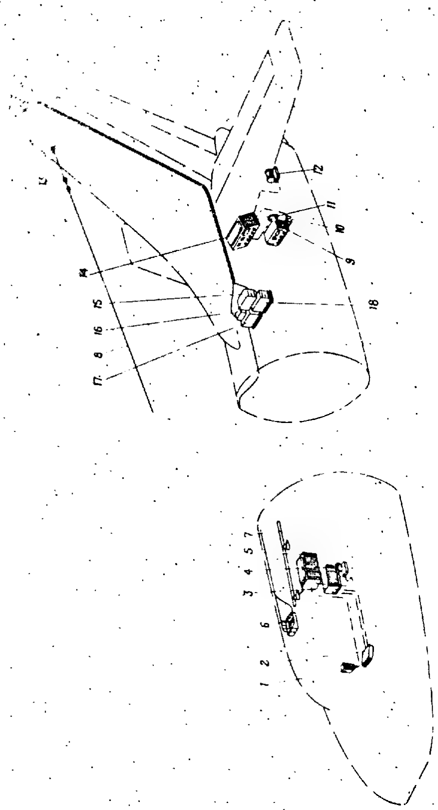


FIG 61 ARRANGEMENT DIAGRAM OF COMMUNICATION RADIO SETS

1 – remote control panel of command set 1-РСБ-70М; 2 – control panel of command set receiver УС-9Д; 3 – receiver УС-9Д; 4 – dynamotor У-600 of the transmitter of command set 1-РСБ-70М; 5 – transmitter of command set 1-РСБ-70М; 6 – control panels of the РСИУ-3М command set; 7 – folded-dipole antenna of command set 1-РСБ-70М; 8 – wire antenna of communication set 1-РСБ-70М; 9 – receiver УС-9 of communication set; 10 – telegraph key panel of the communication set; 11 – radio operator's electric board monitoring and telegraph key switches; 12 – dynamotor of communication set transmitter; 13 – tail outboard antennas of communication set РСИУ-3М; 14 – communication transmitter of command set 1-РСБ-70М; 15 – receiver No. 2 of communication set РСИУ-3М; 16 – selenium rectifier of РСИУ-3М supply units; 17 – РСИУ-3М transmitter; 18 – receiver No. 1 of РСИУ-3М command set.

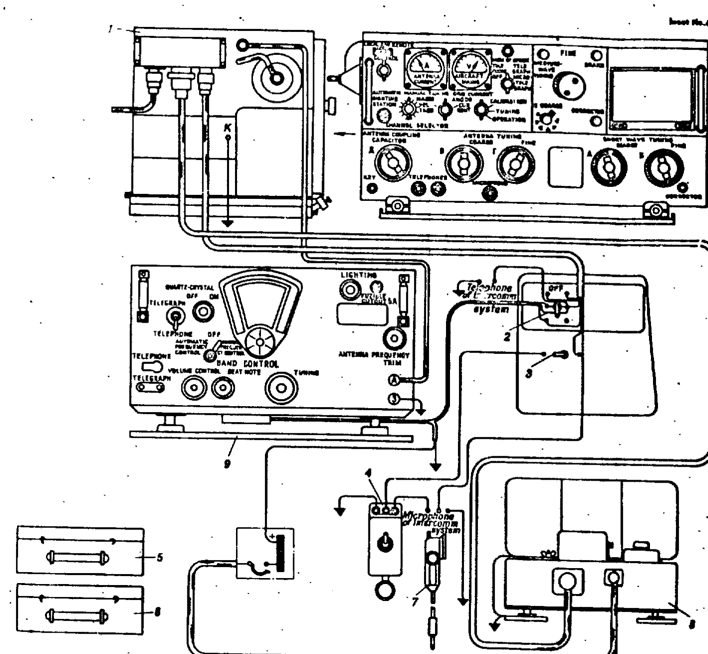


FIG. 62. DIAGRAM OF COMMUNICATION SET 1-PCB-70

1 – transmitter of set 1-PCB-70; 2 – self-monitoring switch; 3 – telegraph key switch; 4 – telegraph key panel; 5 – box containing spare tubes for the transmitter; 6 – box containing spare tubes for the receiver; 7 – microphone; 8 – dynamotor У-600; 9 – receiver УС-9.

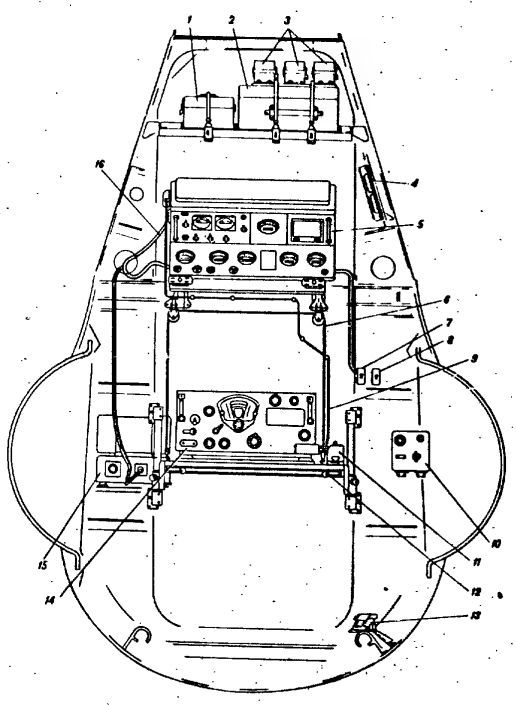


FIG. 63. ARRANGEMENT DIAGRAM OF COMMUNICATION SET 1-PCB-70M

1 – box with spare tubes for receiver УС-9; 2 – box with spare tubes for transmitter of set 1-PCB-70; 3 – boxes with crystals for set РСИУ-3М; 4 – split boxes of intercom system СПУ-10 of the radio operator; 5 – communication transmitter of set 1-PCБ-70; 6 – shock-absorbing cables of the radio operator's table; 7 – monitoring switch; 8 – telegraph key switch (for command set transmitter 1-PCБ-70M); 9 – antenna fair-lead of receiver УС-9; 10 – radio operator's СПУ-10 interphone set; 11 – telegraph key panel; 12 – radio operator's table; 13 – foot switch of the radio operator's intercom set; 14 – receiver УС-9; 15 – dynamotor У-600 (installed next to frame No. 75); 16 – antenna fair-lead of transmitter of set 1-PCБ-70.

25X1

25X1

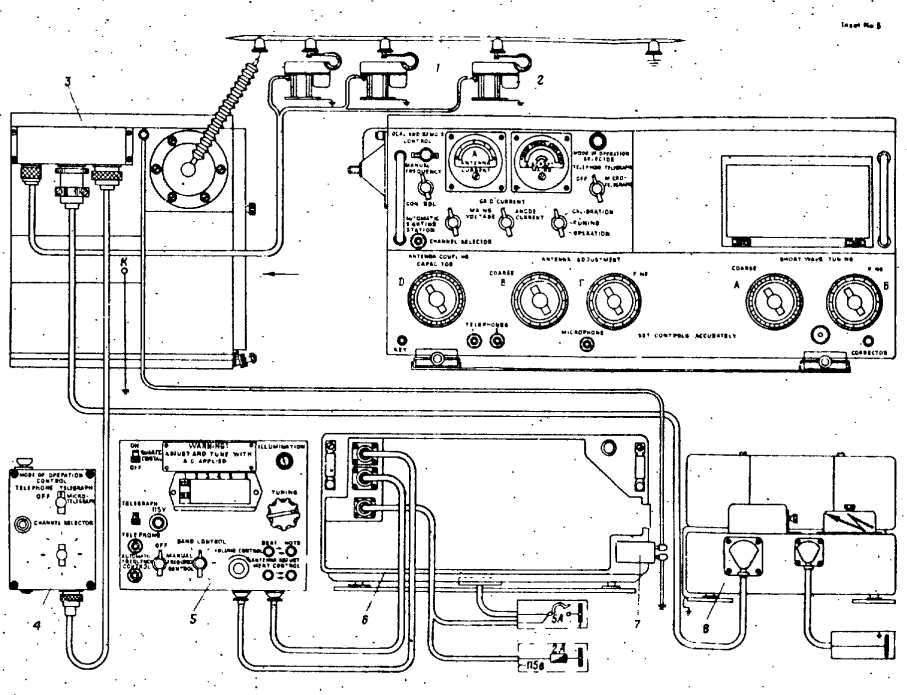


FIG. 64. DIAGRAM OF COMMAND RADIO SET 1-PCB-70M

1 – folded-dipole antenna; 2 – relay PC; 3 – transmitter 1-PCB-70M; 4 – transmitter remote control panel, 5 – remote control panel of receiver УС-9Д; 6 – receiver УС-9Д; 7 – antenna filter АФУС-9Д; 8 – dynamotor Д-600.

25X1

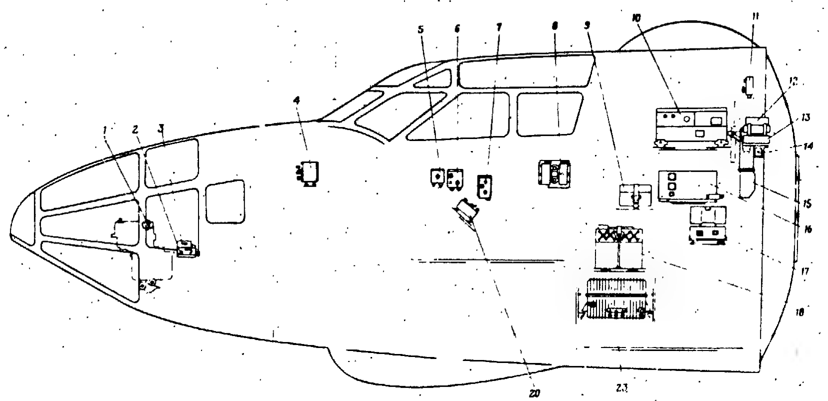


FIG. 65. ARRANGEMENT OF RADIO EQUIPMENT IN FRONT CABIN (STARBOARD)

1 – intercom system button on bracket of course stabilizer АП-5-2М; 2 – navigator's intercom set of СПУ-10; 3 – additional panel of the navigator's intercom equipment, 4 – r.f. filter СПФ-1; 5 – additional panel of the co-pilot's intercom equipment; 6 – co-pilot's intercom set; 7 – remote control panel of transmitter of radio set 1-РСБ-70М; 8 – split boxes of intercom system; 9 – box with spare tubes for transmitter of radio set 1-РСБ-70М; 10 – transmitter 1-РСБ-70М; 11 – operator's intercom set; 12 – amplifier of intercom system; 13 – dynamotor of aircraft intercom system No. 2; 14 – filter of intercom system No. 2; 15 – indicator of radar bomb sight РБП-4 with camera ФА-РЛ-1; 16 – command set receiver УС-9Д; 17 – dynamotor У-600; 18 – emergency radio set АВРА-45; 19 – modulator of РБП-4 sight; 20 – remote control panel of receiver УС-9Д.

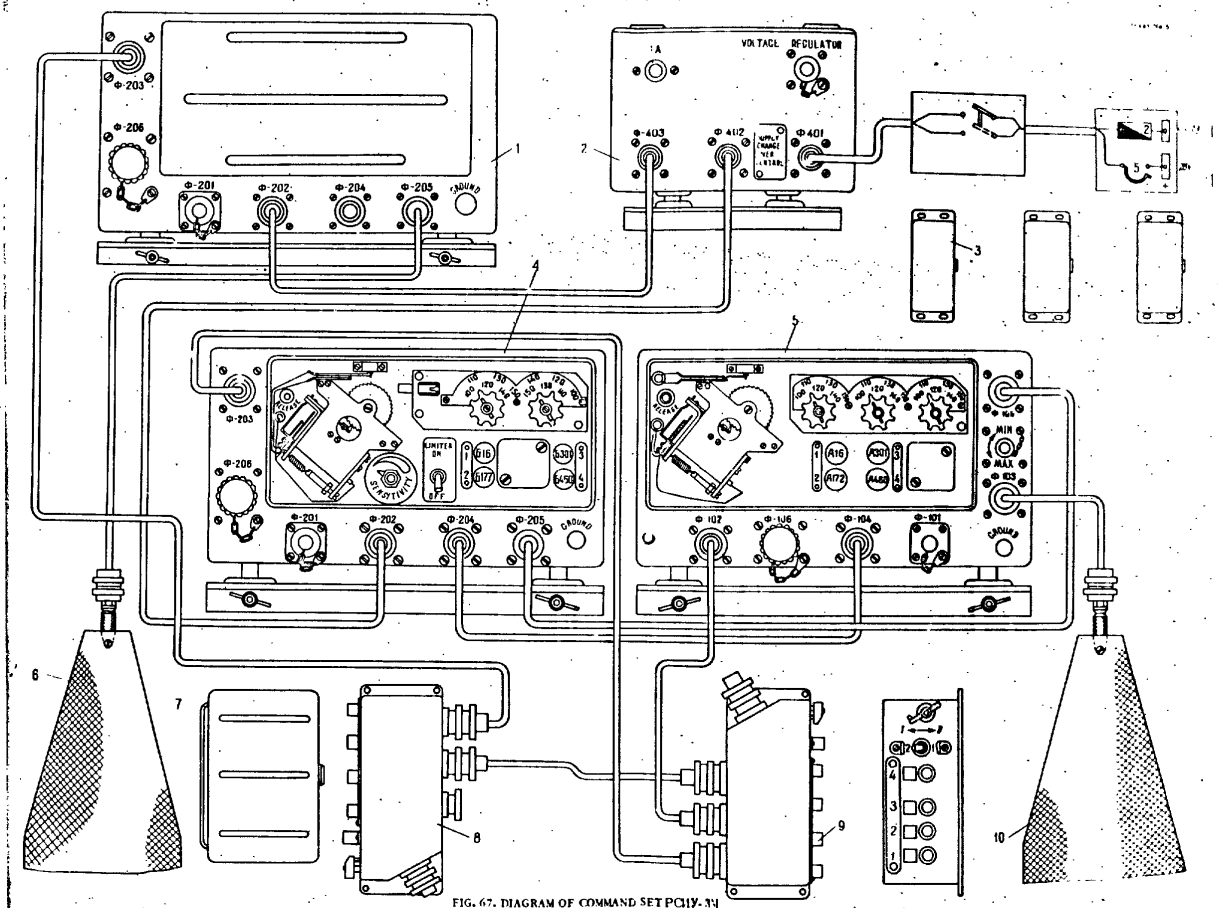


FIG. 67. DIAGRAM OF COMMAND SET PCMY-3M

3 – receiver No. 2 of command set PCMY-3M; 2 – selenium rectifier; 3 – for crystals; 4 – receiver No. 1 of set PCMY-3M; 3 – transmitter of PCMY-3M; 6 – receiving antenna of receiver No. 2; 7 – unit "M" for tuning the set; 8 – control panel of receiver No. 2 and transmitter; 10 – receive-transmit antenna of receiver No. 1 and transmitter.

25X1

25X1

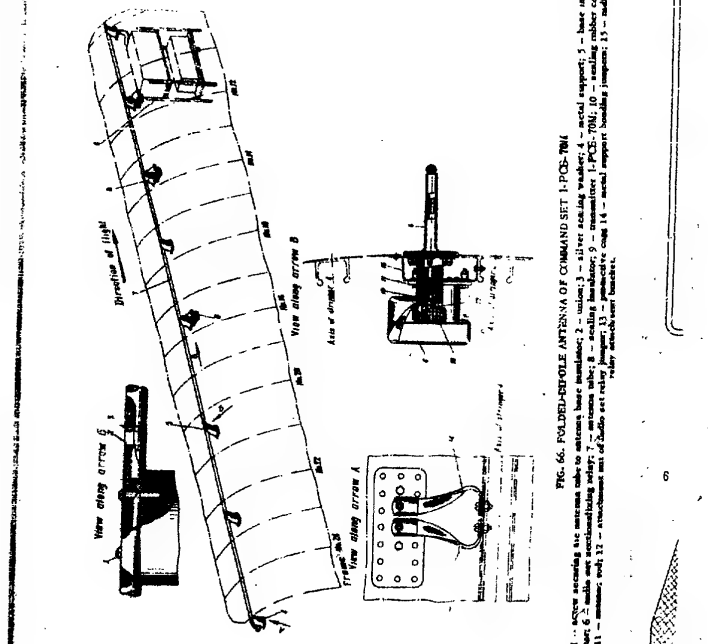


FIG. 66. FOLDED-DIPOLE ANTENNA OF COMMAND SET 1-POS-70M

1 — screw securing the antenna tube to antenna base insulator; 2 — union; 3 — silver sealing washer; 4 — metal support; 5 — base insulator; 6 — radio set sectionalizing relay; 7 — antenna tube; 8 — sealing insulator; 9 — transmitter 1-POS-70M; 10 — sealing rubber cone; 11 — antenna rod; 12 — attachment nut of radio set relay jumper; 13 — protective cap; 14 — metal support bonding jumpers; 15 — radio relay antenna set bracket.

S-E-C-R-E-T

25X1

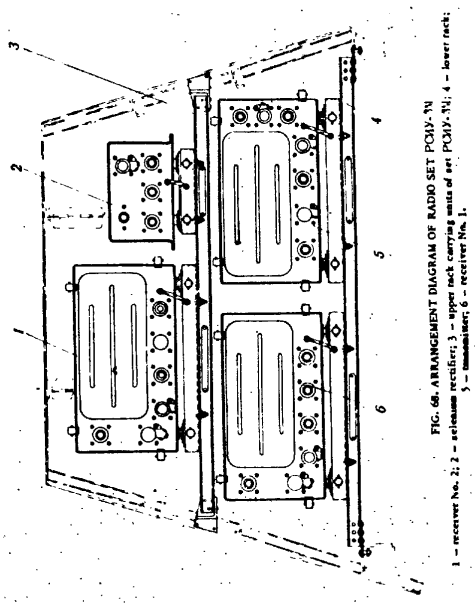


FIG. 68. ARRANGEMENT DIAGRAM OF RADIO SET PO-10-TN

1 – receiver No. 2; 2 – selenium rectifier; 3 – upper rack carrying units of set PO-10-TN; 4 – lower rack; 5 – transmitter; 6 – receiver No. 1.

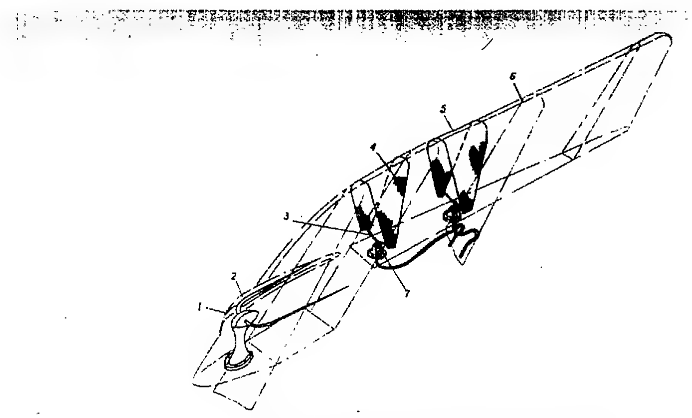


FIG. 69. ARRANGEMENT DIAGRAM OF FIN ANTENNA

1 – vitrified cloth dome for course receiver antenna; 2 – antenna of course receiver KPL-Ф; 3 – grid antenna bonding strip; 4 – receive-transmit antenna of set PCИУ-3M; 5 – receiving antenna of receiver No. 2 of radio set PCИУ-3M; 6 – fin wooden fairing; 7 – r.f. connector.

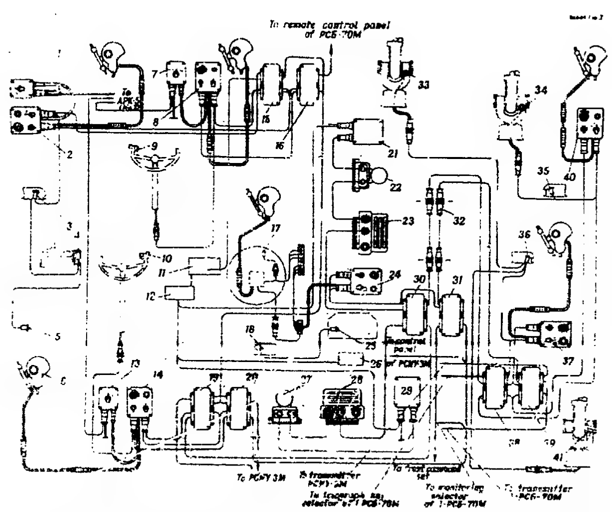


FIG. 70. DIAGRAM OF INTERCOM SYSTEM CПУ-10

1 – navigator's additional panel of intercom system; 2 – navigator's intercom set; 3 – navigator's foot button switch; 4 – button on AП-5-2M course stabilizer; 5 – button on navigator's control panel; 6 – head set with throat microphone and connecting cables; – pilot's additional panel; 8 – co-pilot's intercom set; 9 – CПУ (INTERCOM SYSTEM) and PAДИО (RADIO SETS) buttons on the co-pilot's control wheel; 10 – CПУ (INTERCOM SYSTEM) and PAДИО (RADIO SETS) buttons on pilot's control wheel; 11 – circuit breaker panel of co-pilot; 12 – pilot's overhead upper electric panel; 13 – pilot's additional panel; 14 – pilot's intercom set; 15, 19, 30, 38 – aircraft intercom junction box A; 16, 20, 3., 39 – aircraft communication junction box Б, 17 – intercom system button on radar operator's sighting station; 18 – operator's foot button switch of intercom system; 21 – aircraft noise filter of intercom system No. 2; 22 – dynamotor No. 2 of intercom system; 23 – amplifier No. 2 of intercom system; 24 – operator's intercom set; 25 – button on operator's instrument panel; 26 – operator's electric panel; 27 – dynamotor No. 1 of intercom system; 28 – amplifier No. 1 of intercom system; 29 – aircraft noise filter No. 2 of intercom system; 32 – straight plug connectors; 33 – button of operator's sighting station (starboard blister); 34 – button on gunner's aft sighting station, 35 – gunner's foot button switch; 36 – radio operator's [illegible] switch; 37 – radio operator's intercom set; 40 – gunner's intercom set, 41 – intercom system button on radio operator's port sighting station.

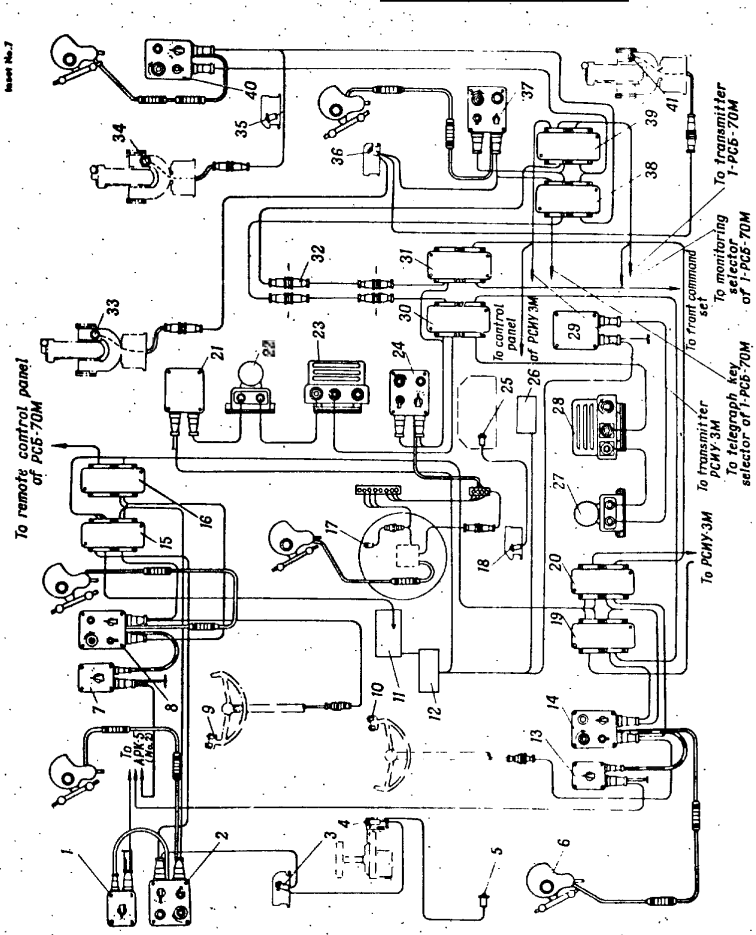


FIG. 70. DIAGRAM OF INTERCOM SYSTEM СПУ-10

1 – navigator's additional panel of intercom system; 2 – navigator's intercom set; 3 – navigator's foot button switch; 4 – button on АП-5-2М course stabilizer; 5 – button on navigator's control panel; 6 – head set with throat microphone and connecting cables; 7 – pilot's additional panel; 8 – corpilot's intercom set; 9 – СПУ (INTERCOM SYSTEM) and РАЦИИ (RADIO SETS) buttons on the co-pilot's control wheel; 10 – СПУ (INTERCOM SYSTEM) and РАЦИИ (RADIO SETS) buttons on pilot's control wheel; 11 – circuit breaker panel of co-pilot; 12 – pilot's overhead upper electric panel; 13 – pilot's additional panel; 14 – pilot's intercom set; 15, 19, 30, 38 – aircraft intercom junction box А ; 16, 20, 31, 39 – outside communication junction box Б ; 17 – intercom system button on radar operator's sighting station; 18 – operator's foot button switch of intercom system; 21 – aircraft mains filter of intercom sytem No. 2; 22 – dynamotor No. 2 of intercom system; 23 – amplifier No. 2 of intercom system; 24 – operator's intercom set; 25 – button on operator's instrument panel; 26 – operator's electric panel; 27 – dynamotor No. 1 of intercom system; 28 – amplifier No. 1 of intercom system; 29 – aircraft mains filter No. 2 of intercom system; 32 – airtight plug connectors; 33 – button of operator's sighting station (starboard blister); 34 – button on gunner's aft sighting station; 35 – gunner's foot button switch; 36 – radio operator's foot button switch; 37 – radio operator's intercom set; 40 – gunner's intercom set; 41 – intercom system button on radio operator's port sighting station.

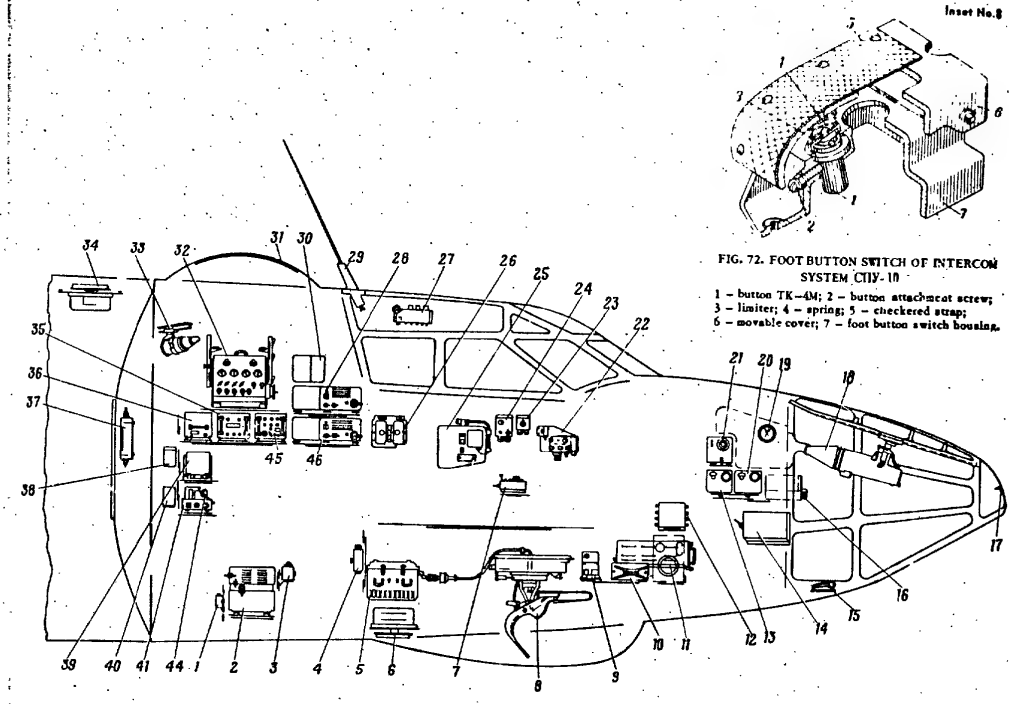


FIG. 71. DIAGRAM OF RADIO EQUIPMENT LOCATED IN NOSE CABIN (PORT SIDE)

1 – filter Ф14-А of transponder set; 2 – transponder; 3 – transponder inertia switch; 4 – junction box P13 (radar bombsight РБП-4); 5 – transmitter receiver P2 (unit РБП-4); 6 – loop antenna of automatic radio compass АРК–5 No. 2; 7 – pilot's control panel of automatic radio compass АРК–5 No. 1; 8 – antenna P1 (РПБ-4 bombsight); 9 – receiver ГРП-2; 10 – ILS junction box; 11 – bombardier's synchronizer P7 (radar bombsight РБП-4); 12 – junction box P14 (radar bombsight РБП-4); 13 – automatic radio compass No. 2 control panel; 14 – bombardier's control panel P9 (radar bombsight РБП-4); 15 – intercom system foot button; 16 – intercom system button; 17 – glide-path receiver antenna; 18 – bombardier's indicator P8; 19 – two-pointer course indicator УШБ-1; 20 – automatic radio compass No. 1 control panel; 21 – indicator of radio altimeter РВ–17М; 22 – control panels of СД-1 and КРП-Ф, ГРП-2; 23 – pilot's additional panel of intercom system; 24 – pilot's intercom set; 25 – panel with code board, destructor button and transponder switch; 26 – intercom system distribution box; 27 – control panels of radio set РСИУ-3М; 28 – receiver of automatic radio compass РК–5 No. 1; 29 – rod antenna of automatic radio compass No. 1; 30 – relay box of automatic radio compass No. 1; 31 – antenna of automatic radio compass No. 2; 32 – operator's control panel P6 of radar bombsight РБП-4; 33 – operator's indicator P5/1; 34 – loop antenna of automatic radio compass No. 2; 35 – operator's synchronizer P4; 36 – regulated rectifier; 37 – junction box P15; 38 – filter of intercom system No. 2; 39 – high voltage rectifier; 40 – filter of intercom system No. 2; 41 – amplifier of intercom system No. 1; 42 – dynamotor of intercom system No. 1; 43 – range unit P3 (radar bombsight РБП-4); 44 – receiver of automatic radio compass No. 2.

FIG. 72. FOOT BUTTON SWITCH OF INTERCOM SYSTEM СПУ-10

1 – button ТК–4М; 2 – button attachment screw; 3 – limiter; 4 – spring; 5 – checkered strap; 6 – movable cover; 7 – foot button switch housing.

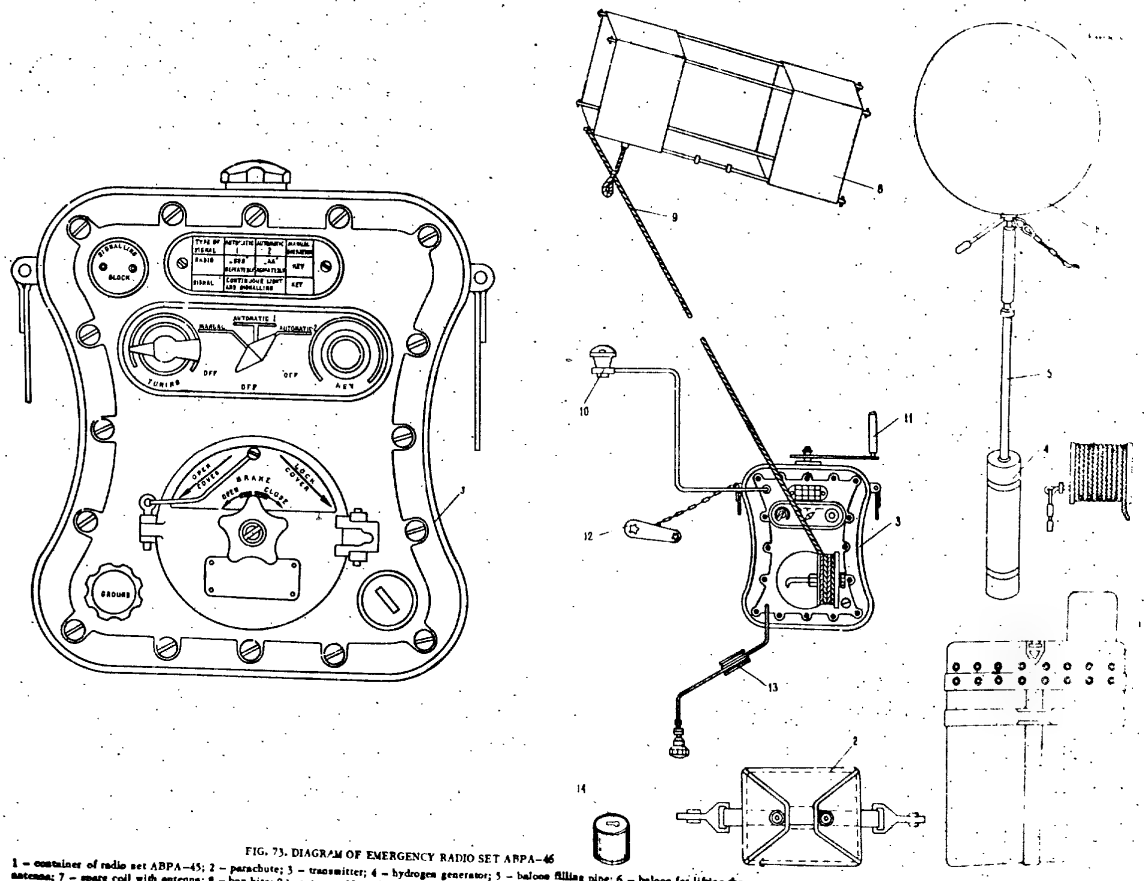


FIG. 73. DIAGRAM OF EMERGENCY RADIO SET ABPA-46

1 – container of radio set ABPA-45; 2 – parachute; 3 – transmitter; 4 – hydrogen generator; 5 – baloon filling pipe; 6 – baloon for lifting the antenna; 7 – spare coil with antenna; 8 – box kite; 9 – antenna; 10 – signalling lamp; 11 – crank to rotate the generator; 12 – wrench for unscrewing plugs; 13 – grounding wire (counterweight); 14 – can with a spare baloon.

25X1

25X1

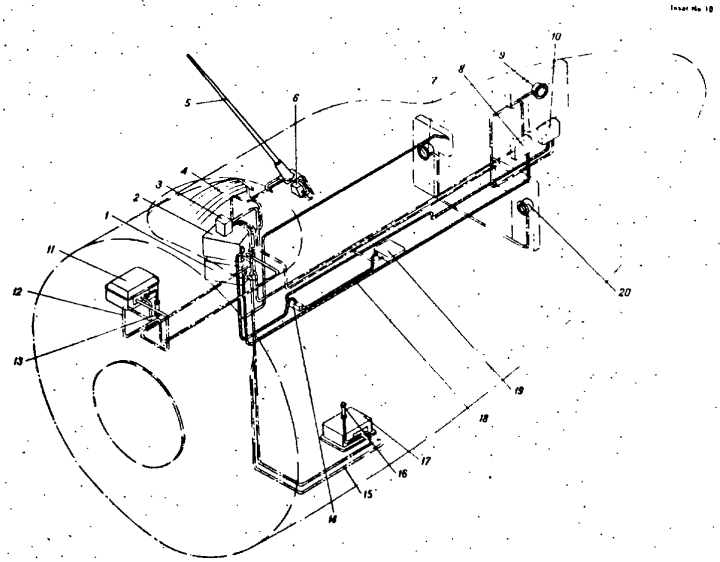


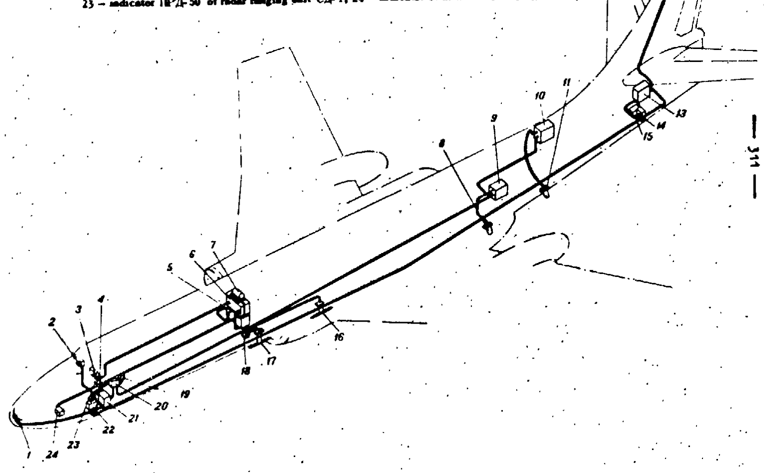
FIG. 74. ARRANGEMENT DIAGRAM OF RADIO NAVIGATION FACILITIES
(AUTOMATIC RADIO COMPASSES NOS 1 AND 2)

1 – receiver of automatic radio compass APK–5 No. 2; 2 – receiver of automatic radio compass No. 1; 3 – box of APK–5 No. 1; 4 – blister antenna of APK–5 No. 2; 5 – rod antenna of APK–5 No. 1; 6 – rod antenna switch-over distribution box; 7 – indicator БСУП-1 of pilot's automatic radio compass No. 1; 8 – control panel of radio compass No. 2; 9 – navigator's two-pointer indicator УШБ-1 of automatic radio compass Nos 1 and 2; 10 – control panel of automatic radio compass No. 1; 11 – inboard loop antenna of automatic radio compass No. 1; 12 – connecting cables of automatic radio compass No. 1; 13 – silica gel cell of automatic radio compass No. 1; 14 – flexible shaft tee-piece of automatic radio compass No. 1; 15 – connecting cables of automatic radio compass No. 2; 16 – silica gel cell of automatic radio compass No. 2; 17 – inboard loop antenna of automatic radio compass No. 2; 18 – flexible shafts to operate the receivers of the automatic radio compass APK–5; 19 – pilot's control panel of automatic radio compass APK–5 No. 1; 20 – indicator БСУП-1 of co-pilot's automatic radio compass APK–5 No. 2.

25X1

[redacted] 25X1

[redacted] 25X1



ARRANGEMENT DIAGRAM OF THE RADIO NAVIGATION EQUIPMENT AND ALTIMETERS

1 – dipole antenna of glide-path receiver ГРП-2; 2, 4 – instrument landing indicator ГСП-48 of the pilot and co-pilot; 3 – indicator ПРВ-46 of radio altimeter РВ–2; 5 – transceiver of radio altimeter РВ–17М; 6 – transceiver РВ–2; 7 – dynamotor РУ-11А with filter (РВ–2); 8 – receiving antenna of radar ranging unit СД-1; 9 – receiver of radar ranging unit СД-1; 10 – transmitter of radar ranging unit СД-1; 11 – transmitting antenna of radar ranging unit СД-1; 12 – antenna of course receiver КРП-Ф; 13 – receiver КРП-Ф; 14 – marker receiver МРП-4П; 15 – inboard antenna of receiver МРП-48Г; 16 – transmitting antenna of radio altimeters РВ–17–РВ–2; 17 – receiver antenna of radio altimeters РВ–17 – РВ–2; 18 – antenna selector АП-1 of radio altimeters; 19 – ILS control panel; 20 – control panel of radar ranging unit СД-1; 22 – glide-path receiver ГРП-2; 23 – indicator ПРД-50 of radar ranging unit СД-1; 24 – indicator of altimeter РВ–17М.

[redacted] 25X1

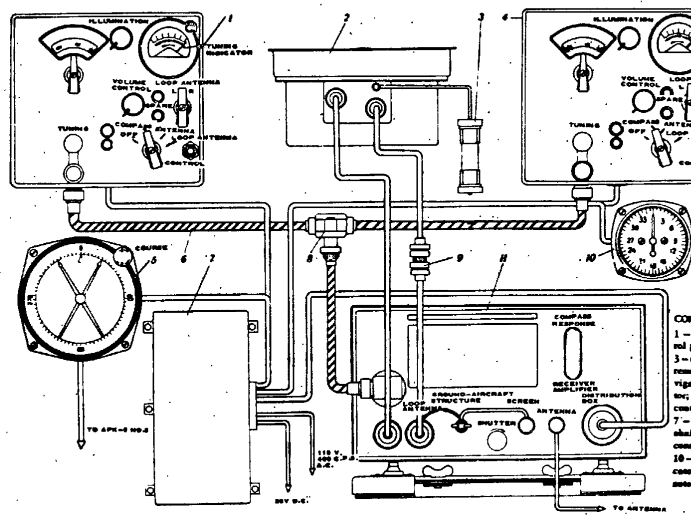


FIG.76. DIAGRAM OF AUTOMATIC RADIO COMPASS RECEIVER NO.1

1 – navigator's remote control panel; 2 – loop antenna; 3 – silica gel cell; 4 – pilot's remote control panel; 5 – navigator's two-pointer indicator; 6 – receiver remote control flexible shafts; 7 – relay box; 8 – flexible shaft tee-piece; 9 – airtight connector of r.f. cable; 10 – pilot's one-pointer indicator; 11 – receiver of automatic radio compass APK-5.

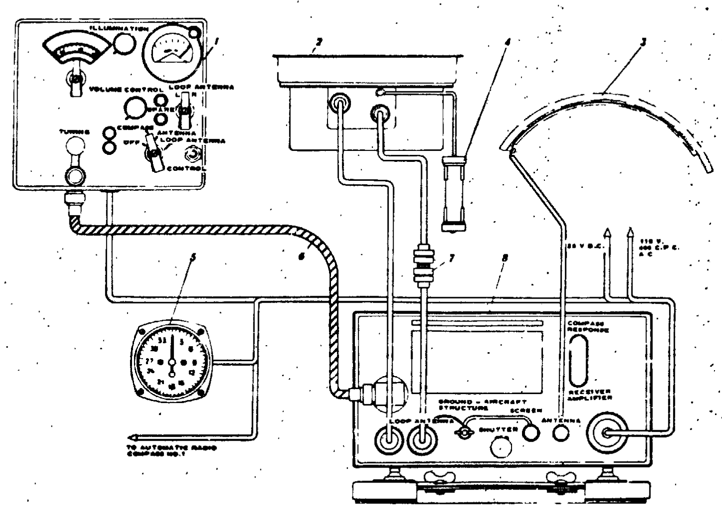


FIG. 77. DIAGRAM OF RECEIVER NO. 2 OF AUTOMATIC RADIO COMPASS

1 – navigator's control panel; 2 – loop antenna; 3 – blister non-directed antenna; 4 – silica gel cell; 5 – co-pilot's indicator; 6 – flexible shaft; 7 – airtight connector of r.f. cable; 8 – receiver No. 2.

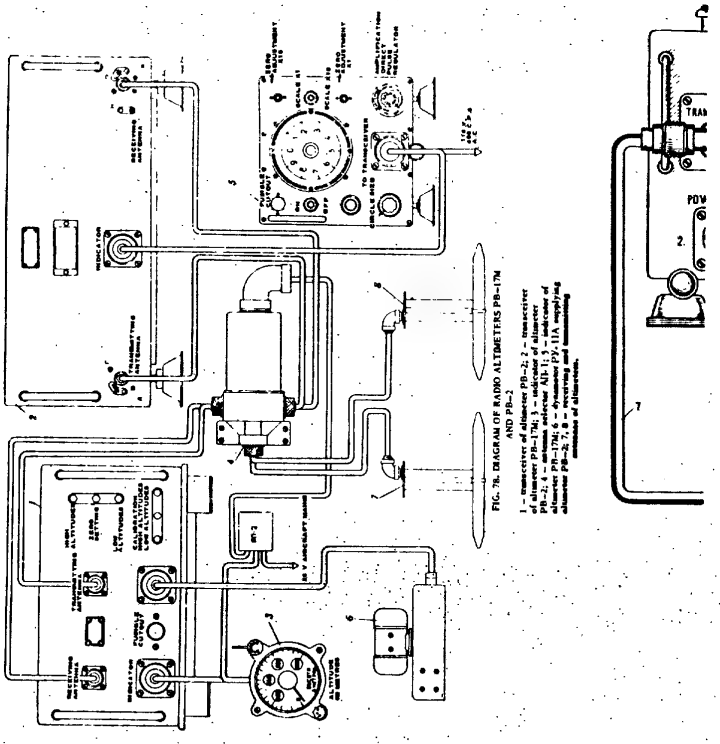


FIG. 78. DIAGRAM OF RADIO ALTIMETERS PB–1N AND PB–2

1 – transceiver of altimeter PB–2; 2 – transceiver of altimeter PB–1N; 3 – indicator of altimeter PB–2; 4 – antenna selector AB-1; 5 – indicator of altimeter PB–1N; 6 – transformer PO-115A supplying altimeter PB–2; 7, 8 – directional antennas for measuring altitudes of altimeters.

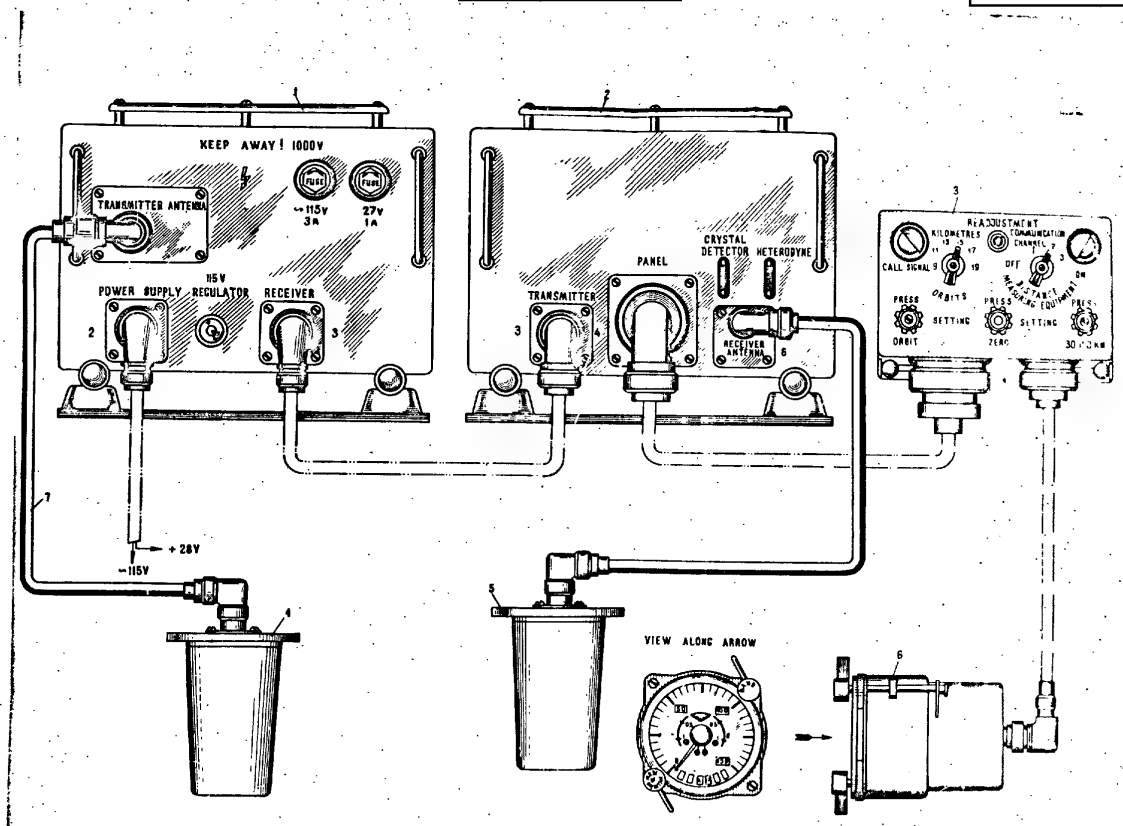


FIG. 79. DIAGRAM OF RADAR RANGING UNIT CA-1

1 – transmitter; 2 – receiver; 3 – control panel; 4 – transmitting antenna; 5 – receiving antenna; 6 – radar ranging unit indicator; 7 – r.f. antenna cables.

25X1

25X1

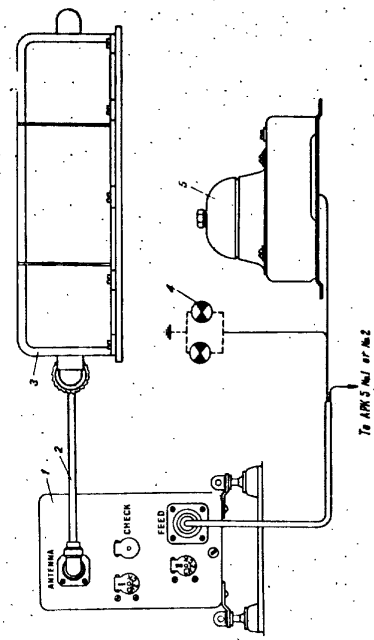
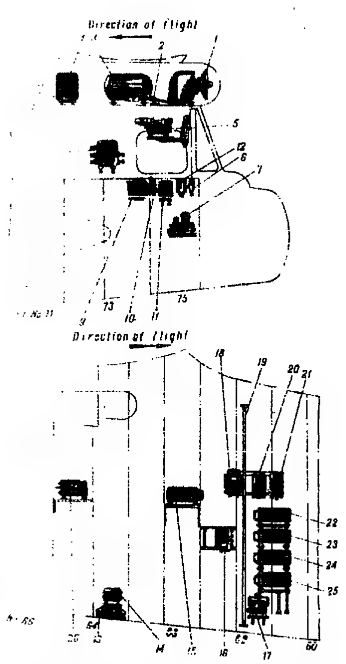


FIG. 80. DIAGRAM OF MARKER RECEIVER

1 – receiver; 2 – r.f. cable; 3 – inboard antenna; 4 – warning lamp; 5 – bell.

25X1



...81. RADIO AND RADAR EQUIPMENT LOCATED IN TAIL PORTION OF AIRFRAME AND REAR CABIN

...antenna AP17–1 of radar gunsight ПРС-1; 2 – waveguide AP17–25; 3 – trans... AP18–2; 4 – gyro unit AP17-19Д; 5 – indicator AP17-4Д; 6 – mode-of-opera... selector panel AP17-17Д; 7 – dynamotor У-600; 8 – coupling box AP17–8E; ...intercom set of rear gunner; 10 – trigger AP17–16; 11 – control panel AP17-7Д; ... search control panel AP17-14Д; 13 – inboard antenna of marker receiver ...48П; 14 – receiver МРП-48П; 15 – supply unit AP17-12Д of sight ПРС-1; ... junction box AP17–5; 17 – amplidyne unit AP17-8Д; 18 – junction box ...17–6; 19 – guard post of support for units AP17; 20 – range transmission unit ...–21; 21 – supply box AP17-13Д; 22 – servo amplifier unit; 23 – range unit ...17-11Д; 24 – receiver and indicator unit AP17-3Д; 25 – angular tracking unit AP17-10Д; 26 – course receiver КРП-Ф.

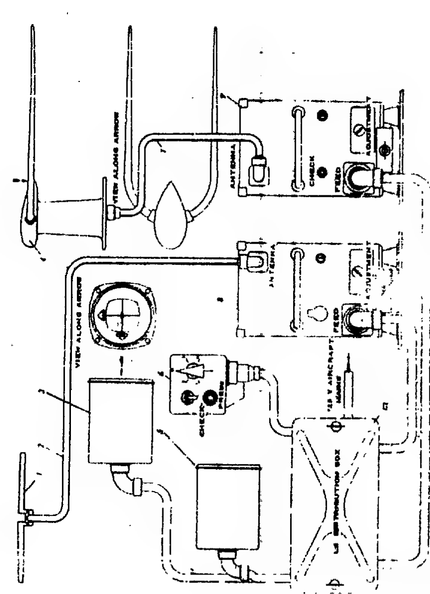


FIG. 82. ILS EQUIPMENT DIAGRAM

1 – glide-path receiver antenna; 2, 7 – r.f. cables; 3, 5 – indicators [illegible]; 4 – course receiver antenna; 6 – control panel; 8 – glide path receiver ГРП-2; 9 – course receiver КРП-Ф; 10 – ILS distribution box.

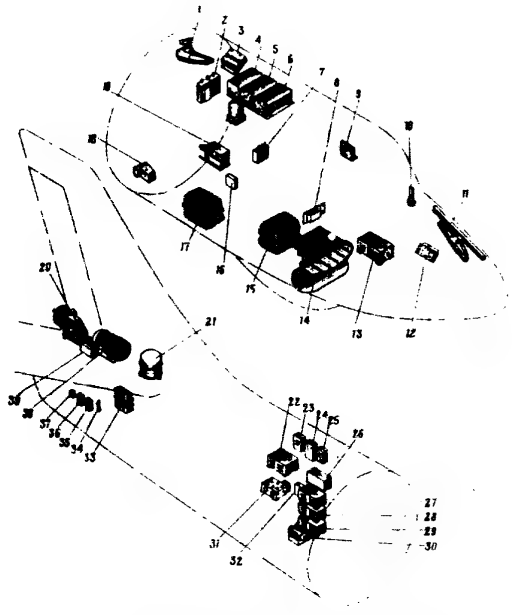


FIG. 83. LAYOUT OF RADAR EQUIPMENT IN AIRCRAFT

1 – indicator P-5/1 of navigator-operator's radar bombsight PBP- 4; 2 – feeding box P15 of radar bomb sight PBP- 4; 3 – control panel P6 of operator's radar bombsight PBP- 4; 4 – regulated rectifier P11; 5 – range unit P3; 6 – operator's synchronizer P4; 7 – junction box P13; 8 – control panel of tail warning radar "SIREN-2"; 9 – interrogation code panel and destructor button, 10 – junction box P14; 11 – navigator-bombardier's indicator P8; 12 – navigator-bombardier's control panel P9; 13 – navigator-bombardier's synchronizer P7; 14 – antenna P1 of radar bombsight PBP- 4; 15 – transceiver P2; 16 – inertia contactor to close destructor circuit; 17 – modulator P12; 18 – gang unit of radar bombsight and tail warning system; 19 – transponder P2; 20 – antenna AP1"-1 of radar gunsight ПРС-1; 21 – gyro instrument AP17-11Д; 22 – supply unit AP17-12Д; 23 – junction box AP17-6; 24 – range transmitting unit AP17-21Д; 25 – feed box AP17-13Д; 26 – range unit AP17-11Д; 27 – angle tracking unit AP17-10Д; 28 – receiver indicator unit AP17-3Д; 29 – servo amplifier unit AP17-20Д; 30 – amplidyne AP17-9Д; 31 – junction box AP17; 32 – gang unit for gunsight ПРС-1 and tail "SIREN-2" warning radar; 33 – gang box for antenna AP17 and computer ПВБ- 53 – AP17- 8Б; 34 – fixing bottom AP17–16; 35 – control panel AP17–9Д; 36 – scan control panel AP17- 14Д; 37 – remote control panel AP17- 17Д; 38 – transceiver АР -18–2; 39 – indicator AP17- 4Д; 40 – high-voltage rectifier P15.

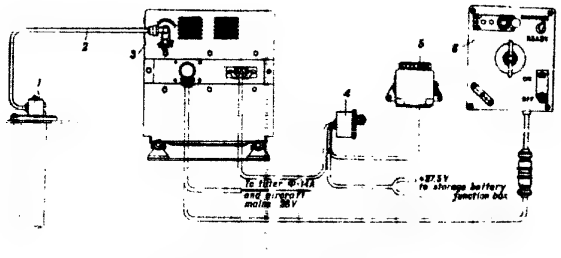


FIG. 84. TRANSPONDER ARRANGEMENT DIAGRAM

1 – transponder transmit-receive antenna; 2 – r.f. antenna cable; 3 – transponder; 4 – destructor button; 5 – inertia contactor; 6 – code panel with cable and plug connector.

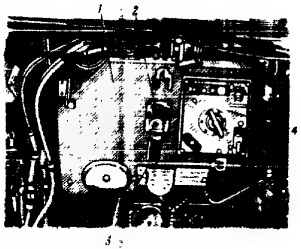


FIG. 85. TRANSPONDER UNITS INSTALLED WITHIN REACH OF THE PILOT

1 – transponder unit board; 2 – transponder destructor button with indicating lamp; 3 – transponder feed switch; 4 – transponder code panel.

25X1

25X1

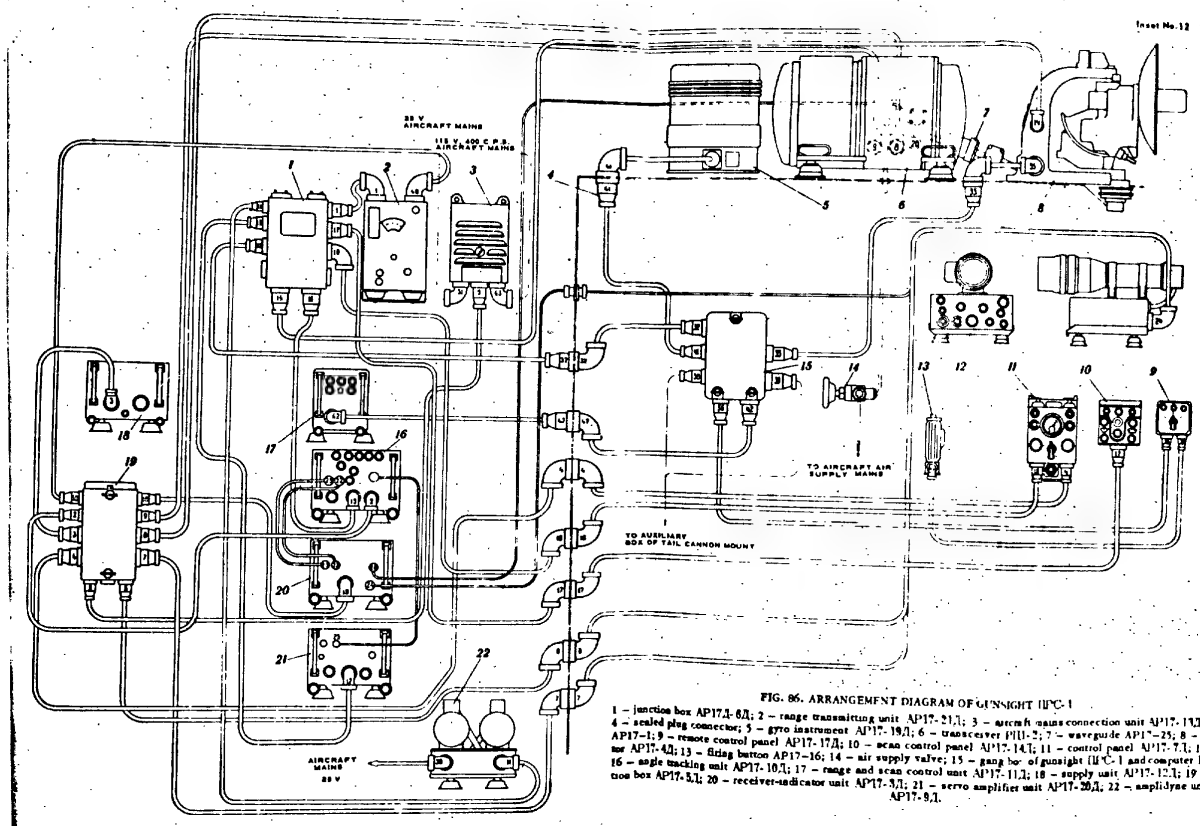


FIG. 86. ARRANGEMENT DIAGRAM OF GUNSIGHT ПРС-1

1 – junction box АР17-1.Д; 2 – range transmitting unit АР17-21.Т; 3 – aircraft mains connection unit АР17-17.Д; 4 – sealed plug connector; 5 – gyro instrument АР17-19.Л; 6 – transceiver РПП-2; 7 – waveguide АР17-25; 8 – antenna АР17-4.Д; 13 – firing button АР17-16; 14 – air supply valve; 15 – gang box of gunsight ПРС-1 and computer ПРБ-13; 16 – angle tracking unit АР17-10.Д; 17 – range and scan control unit АР17-11.Д; 18 – supply unit АР17-12.Т; 19 – junction box АР17-3.Т; 20 – receiver-indicator unit АР17-3.Л; 21 – servo amplifier unit АР17-20.Д; 22 – amplidyne unit АР17-9.Т.

25X1

FIG. 87. UNITS AP-17 INSTALLED ON HORIZONTAL PLATE OF THE REAR PRESSURIZED CABIN
1 – gyro instrument АДИ-1ВД; 2 – transceiver АР18-2; 3 – antenna АР17-1.

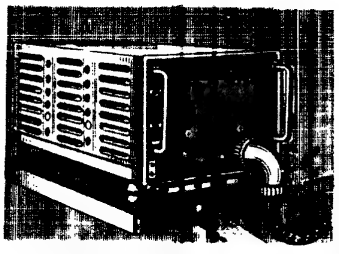


FIG. 88. UNIT АР17-12 INSTALLED ON FUSELAGE STARBOARD NEXT TO FRAME No. 63

25X1

25X1

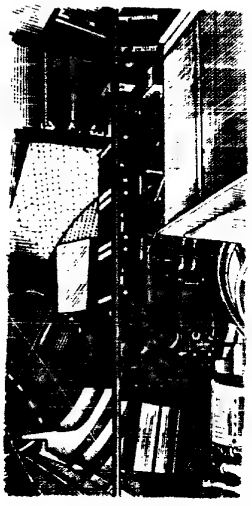


FIG. 89. SUPPORT WITH UNITS AP17 INSTALLED IN NON-PRESSURIZED PORTION OF FUSELAGE NEXT TO FRAME No. 61

25X1

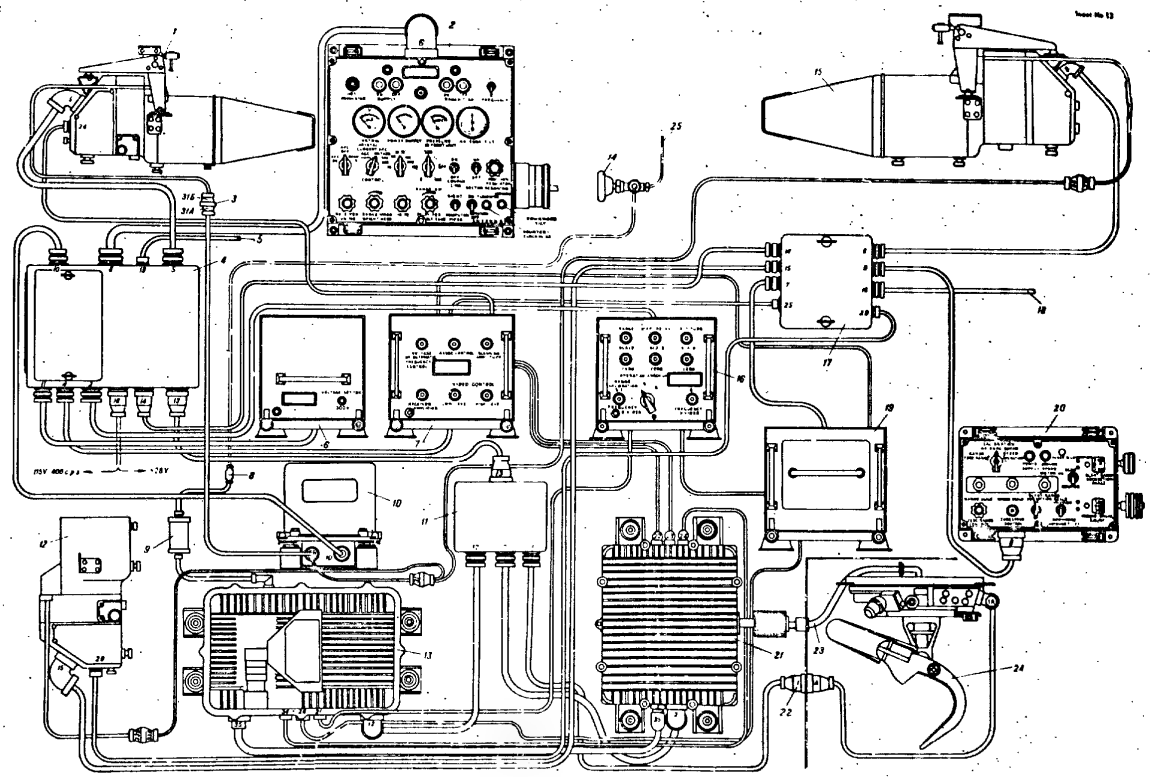


FIG. 90. ARRANGEMENT DIAGRAM OF RADAR BOMBSIGHT РБП-4

1 – navigator-operator's indicator Р5/1; 2 – navigator-indicator's control panel Р6; 3 – high voltage plug connector; 4 – junction feed box Р15; 5 – cable No. 19 to control panel of camera ФА-П3-1; 6 – regulated rectifier Р11; 7 – range unit Р3; 8 – adapter connecting dehumidifier to aircraft air mains; 9 – dehumidifier in the system of air supply to bombsight РБП-4; 10 – high voltage rectifier Р10; 11 – junction box Р13; 12 – indicator Р5/2 for camera ФА-П3-1; 13 – modulator Р12; 14 – valve of air supply to radar sight РБП-4; 15 – navigator-bombardier's indicator Р8; 16 – navigator-operator's synchronizer Р4; 17 – junction box Р14; 18 – cable No. 16 for altitude unit ОПБ-11Г; 19 – navigator-bombardier's synchronizer Р7; 20 – navigator-bombardier's control panel Р9; 21 – transceiver Р2; 22 – sealed plug connector; 23 – waveguide; 24 – antenna Р1; 25 – tube connecting air supply valve to the aircraft air system.

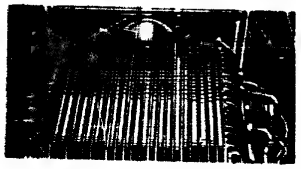


FIG. 91. INSTALLATION OF TRANSCEIVER OF RADAR BOMBSIGHT PSBN-4 (UNIT P2)

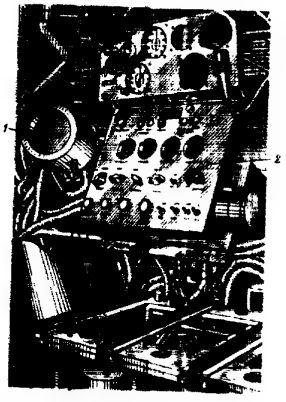


FIG. 92. INSTALLATION OF CONTROL PANEL OF RADAR BOMBSIGHT PSBN-4 (UNIT P6) AND INDICATOR (UNIT P5/1)
1 – unit P5/1; 2 – unit P6 in operating position.

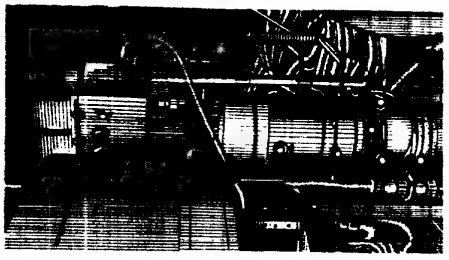
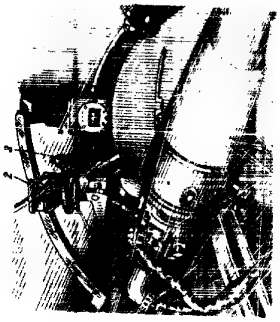


FIG. 94. INSTALLATION OF CAMERA 9A-P/T-1 AND UNIT P5/2



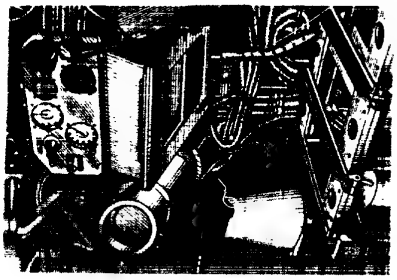
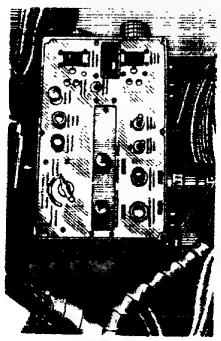


FIG. 95. INSTALLATION OF CONTROL PANEL OF RADAR BOMBSIGHT PSB-4 (UNIT P6) WITHIN OPERATOR'S REACH IN OPERATING POSITION



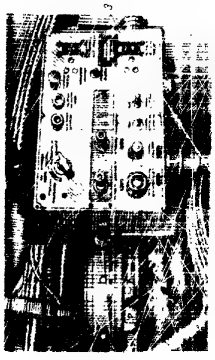


FIG. 96. UNIT P9 IN TRAVELLING POSITION

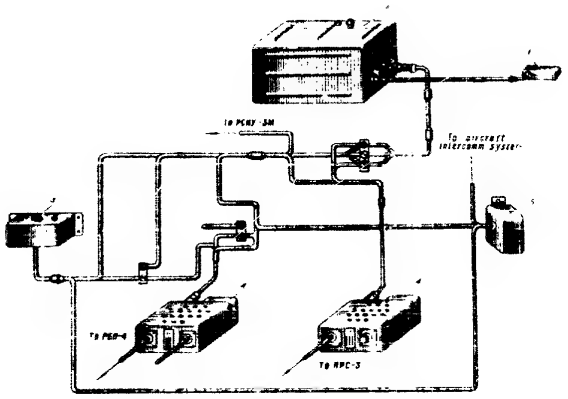


FIG. 98. WIRING DIAGRAM OF TAIL WARNING RADAR "SIREHA-2"

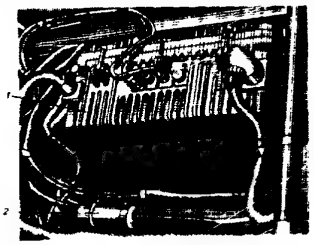
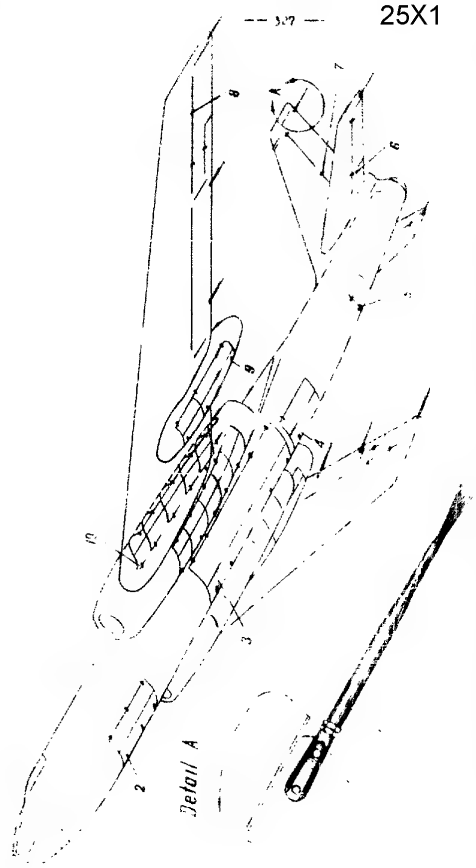
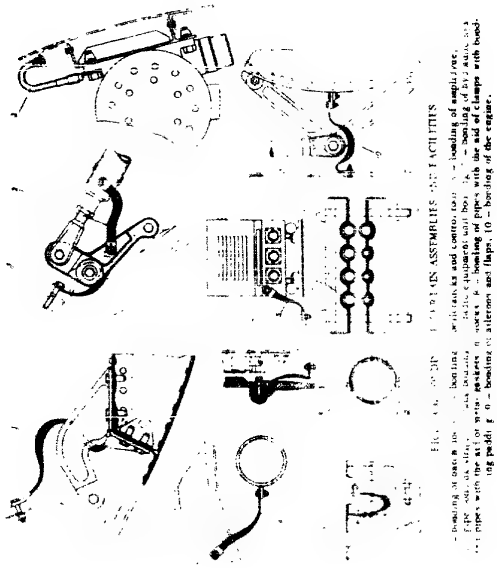


FIG. 99. MODULATOR OF RADAR SIGHT P14B-4 UNIT P12) AND DEHUMIDIFIER IN AIR SUPPLY SYSTEM
1 — unit P12; 2 — dehumidifier cell



25X1

25X1



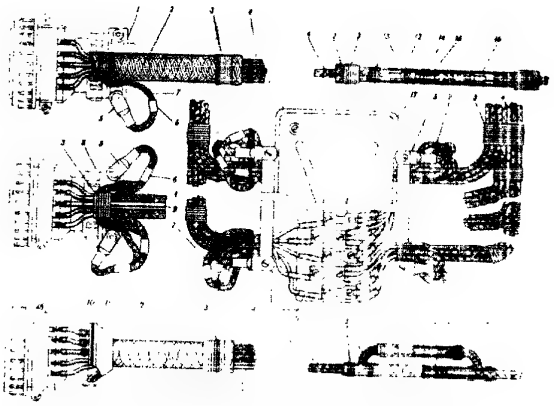


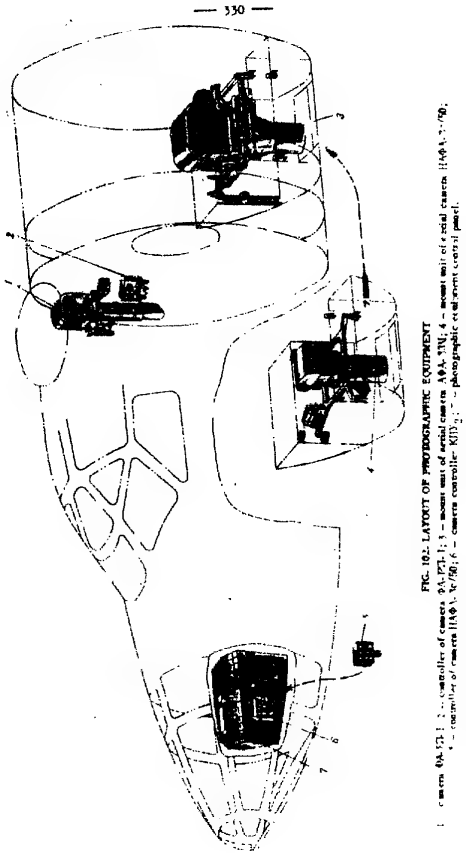
FIG. 101. SCREENING OF BUNCHED CONDUCTORS AND CHANGE-OVER FACILITIES

1 – termination of screened bunched conductor in the plug connector, 2 – branding, 3 – "Stecknyy" thread; 4 – screened wires, 5 – terminal; 6 – connecting pipe, 7 – branding of the screened wires of bunched conductor; 8 – termination for a plug connector and a coupling of bunched conductor made up of screened and non-screened wires; 9 – non-screened wire, 10 – termination of screened bunched conductor for a plug connector and a union nut, 11 – brass holder; 12, 16 – termination of screened wires in individual connector; 13 – thread; 14 – vinyl chloride plastic sleeve; 15 – individual connector; 16 – vinyl chloride plastic sleeve with marking designation of wire, 17 – termination of screened wires in intercom system split box; 18 – terminal lug of screen when connecting the screened wire to the individual connector.

25X1

25X1

25X1



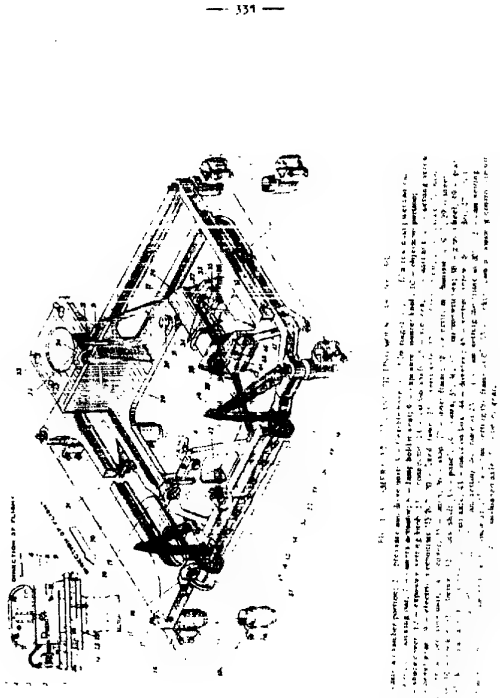


FIG. 102. LAYOUT OF PHOTOGRAPHIC EQUIPMENT

25X1

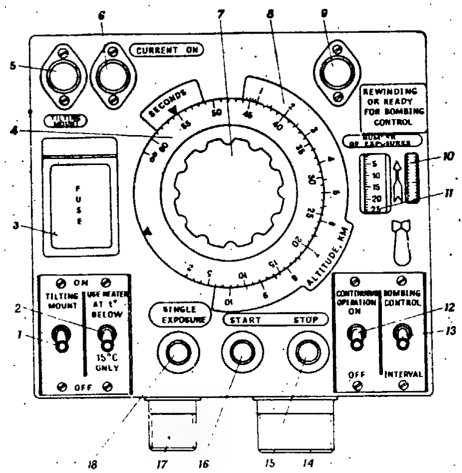


FIG. 104. CAMERA CONTROLLER КПУ$_2$

1 – tilting mount АКАФУ mode-of-operation selector; 2 – camera controller КПУ$_2$ heater switch; 3 – fuse box cover; 4 – white coloured scale; 5 – tilting mount lamp; 6 – CURRENT ON (ТОК ВКЛЮЧЕН) indicating lamp; 7 – setting dial; 8 – yellow coloured scale; 9 – REWINDING (ПЕРЕМОТКА) or READY FOR BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОМЕТАНИЯ) indicating lamp; 10 – exposure counter zero setting disc; 11 – exposure counter; 12 – continuous operation switch; 13 – BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) – INTERVAL (ИНТЕРВАЛ) selector; 14 – camera controller electric cord connecting plug; 15 – camera control-16 – starting button; 17 – two-pin plug; 18 – single exposure button.

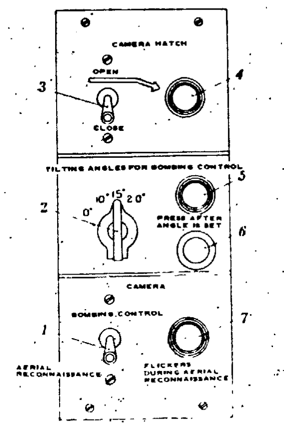


FIG. 105. PHOTOGRAPHIC EQUIPMENT PANEL

1 – tilting mount mode-of-operation selector; 2 – tilting angle setter used for bombing control; 3 – camera hatch door control; 4 – CAMERA HATCH OPEN (ЛЮК ОТКРЫТ) green indicating lamp; 5 – tilting angle yellow indicating lamp for bombing control mode of operation, 6 – button; 7 – white indicating lamp of tilting mount for aerial reconnaissance mode of operation.

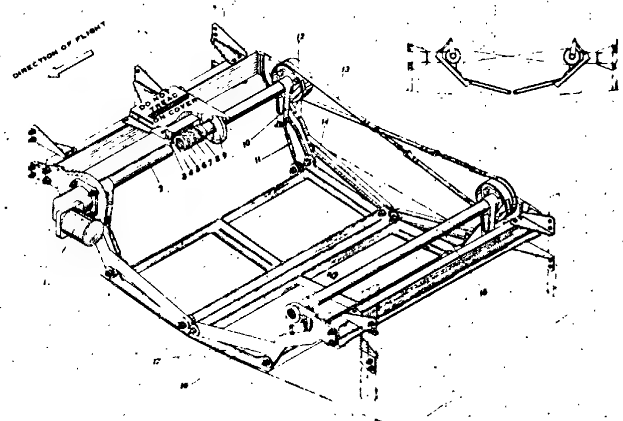


FIG. 106. CAMERA HATCH

1 – electric mechanism УР-7М; 2 – driving shaft; 3 – box; 4 – cam; 5 – camera hatch open position microswitch; 6 – camera НАФА-3с/50 hatch closed position microswitch; 7 – interlocking microswitch of camera НАФА-3с/50; 8 – interlocking switch of АФА-33М; 9 – limiter; 10 – bellcrank; 11 – turnbuckle; 12 – driving pulley; 13 – band; 14 – guide; 15 – driven shaft; 16 – guide; 17 – doors.

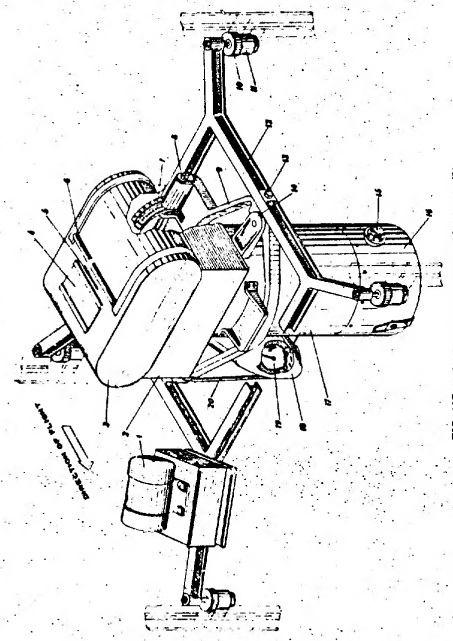


FIG. 107. MOUNT UNIT OF CAMERA НАФА-3с/50

1 – converter РУ-45А; 2 – chamber portion; 3 – film magazine; 4 – celluloid plate; 5 – pins; 6 – gate; 7 – quadrant; 8 – spring-loaded catch; 9 – inner frame; 10 – mirror axis; 11 – spring-loaded shock absorber; 12 – outer frame; 13 – armature; 14 – bracket; 15 – exposure setting knob; 16 – shade; 17 – objective portion; 18 – automatic releaser; 19 – photocell; 20 – suspension bracket.

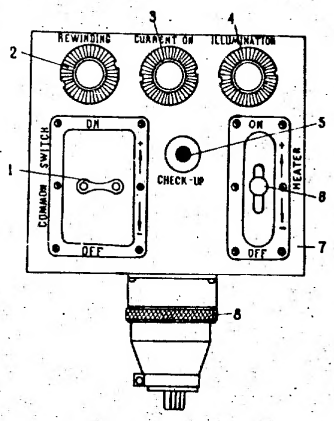


FIG. 108. CONTROLLER OF CAMERA НАФА-3с/50

1 – common switch; 2 – REWINDING (ПЕРЕМОТКА) indicating lamp; 3 – CURRENT ON (ТОК ВКЛЮЧЕН) indicating lamp; 4 – ILLUMINATION (ПОДСВЕТ) indicating lamp; 5 – CHECK-UP (ПРОВЕРКА) button; 6 – heater switch; 7 – camera controller body; 8 – connector.

S-E-C-R-E-T

25X1

25X1

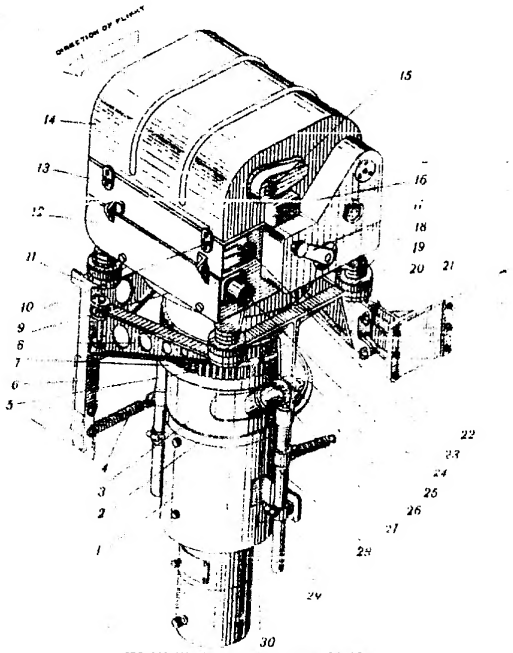


FIG. 109. MOUNT UNIT FOR CAMERA ФАПЗ-1

1 – indicator of radar bombsight ПРС-4; 2 – antenna ring; 3 – jacket; 4 – spring; 5 – focusing ring; 6 – locking pin; 7 – cone portion; 8 – bracket; 9 – base; 10 – lug; 11 – bracket; 12 – chamber cover; 13 – chamber portion; 14 – film magazine; 15 – film rewinding mechanical indicator; 17 – actuator handle; 18 – shock mount; 19 – nave nut; 20 – base sleeve; 21 – bracket; 22 – post; 23 – potentiometer knob; 24 – eight-pin plug; 25 – bolt-lug; 26 – guiding pin; 27 – sight; 28 – post pipe; 29 – indicator attachment bracket; 30 – shock absorber lugs.

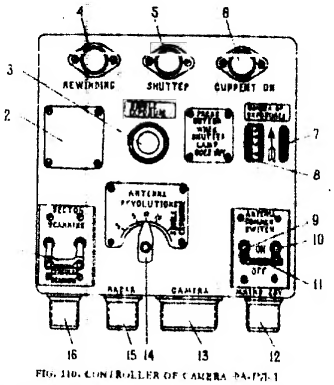


FIG. 110. CONTROLLER OF CAMERA ФАПЗ-1

1 – gang switch; 2 – plate; 3 – single exposure button; 4 – film rewinding indicating lamp; 5 – SHUTTER OPEN indicating lamp; 6 – common switch knob; 7 – dial; 8 – exposure counter drum; 9 – common switch; 10 – antenna switch; 11 – manpiece; 12 – MAINS 26 V (СЕТЬ 26 ВОЛЬТ) socket; 13 – CAMERA (КАМЕРА) socket; 14 – jacket-type switch; 15 – RADAR (РАДИО ВОКЗ ПОРТ) plug; 16 – spare plug.

S-E-C-R-E-T

25X1

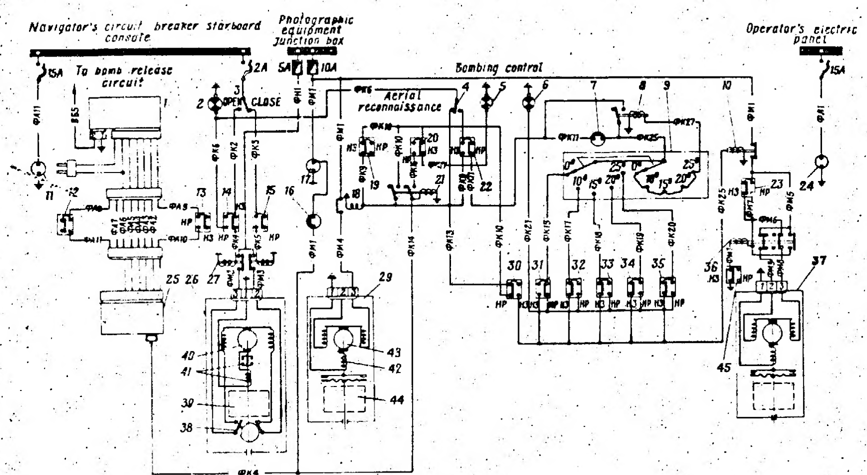


FIG. 111. CIRCUIT DIAGRAM OF PHOTOGRAPHIC EQUIPMENT

1 – camera controller; 2 – CAMERA HATCH OPEN indicating lamp СЛП-51; 3 – camera hatch door control switch ПП-45; 4 – BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) – AERIAL RECONNAISSANCE (РАЗВЕДКА) selector ПП-45; 5 – indicating lamp СЛП-51 marked FLICKERS DURING AERIAL RECONNAISSANCE (МИГАЕТ ПРИ РАЗВЕДКЕ); 6 – indicating lamp СЛП-51 showing that middle frame is set at required angle; 7, 16 – button 5K; 8, 21 – interlocking relay РП-2; 9 – selector П-46; 10, 18, 27, 28 – contactor К-25А; 11, 17, 24 – socket 48К; 12, 13 – camera interlocking limit switches ВК2-140; 14, 15 – limit switches ВК2-140 of camera hatch control circuit interlocking; 19, 20, 22 – limit switches ВК2-140 of inner frame electric mechanism control circuit interlocking, 23, 30, 31, 32, 33, 34, 35, 45 – limit switches ВК2-140 of middle frame electric mechanism control circuit interlocking; 25 – camera; 26 – camera hatch door control electric mechanism УР-7М; 29 – inner frame electric mechanism МУФ-2; 36 – interlocking relay МР-2; 37 – middle frame electric mechanism; 38 – cam with limit switches; 39 – planetary reducing gear; 40, 43 – electric motor; 41, 42 – engagement-braking electromagnetic clutch; 44 – planetary reducing gear; 45 – limit switch.

SECRET

[redacted]

25X1

SECRET

[redacted]

25X1